Shall the Civilization of the Ages
vanish before
the Devilization of the Hun?
One hundred million freemen answer
NO—

# Reconnecting Induction Motors—For Changes in Number of Poles

By A. M. DUDLEY
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*The effect upon the operation of the machine caused by changing the number of poles in an induction-motor winding is discussed. Tables are given in which data are compiled for a 54-coil winding having a coil spread of 1 to 7, reconnected for 4, 6, 8, 10 and 12 poles. These data are discussed in a way that will make them easily applied to any induction-motor winding.*

THE speed of an induction motor expressed in revolutions per minute = (cycles × 120) ÷ number of poles. The speed so determined is called synchronous speed and is very nearly the same as the no-load speed. When operating under full load the speed will be a few revolutions less than this—for ordinary motors, on an average of about 95 to 97 per cent. of the synchronous speed. The synchronous speed is the speed at which the rotating magnetic field is traveling around in the stator, and the difference between this and the full-load speed of the rotor (3 to 5 per cent.) is called the "slip" of the motor.

From the equation for revolutions per minute it can be seen at once that if the speed of the motor is to be changed, it is necessary to change either the cycles or the number of poles. Or, assuming that the cycles have been changed and that it is necessary to keep the same speed as before, it will be necessary to change the number of poles. So far as the cross-connections themselves are concerned, and admitting windings where all the pole-phase groups do not have the same number of coils, as discussed in the article in the May 22, 1917, issue of *Power*, it is evident that any winding might be connected for several different numbers of poles and for either two-phase or three-phase, by the simple expedient of changing the number of coils in each pole-phase group.

For example, a winding having 54 slots and 54 coils if arranged for three-phase 6 poles would have 3 coils per group and 18 pole-phase groups. If the same winding is rearranged for three-phase 4 poles there will be 12 pole-phase groups having alternately 4 and 5 coils per group. Or, if the same winding is arranged for two-phase 4 poles there will be 8 pole-phase groups, 6 of which would have 7 coils and 2 of which would have 6 coils, or 54 total. There are practical limits beyond which this form of reconnection cannot properly be carried and which are discussed farther on in this article, but before proceeding to a discussion of them attention is called to some typical cases of reconnection of this nature.

Fig. 1 shows a 54-slot winding having a coil pitch of 1 and 7 as arranged for 6 poles and connected series star. There are 3 coils in every group. Fig. 2 shows the same winding as Fig. 1 except grouped and connected for 4 poles. It will be noted that there are now $3 \times 4 = 12$ pole-phase groups containing alternately 4 and 5 coils per group. Fig. 3 shows the same winding as in Fig. 1 arranged and connected for 8 poles; there are 18 pole-phase groups with 2 coils and 6 with 3, making a total of 24 groups and 54 coils. Fig. 4 is the same winding as Fig. 1 connected for 10 poles. There are 24 groups having 2 coils each and 6 groups with 1 coil, making a total of 30 pole-phase groups and 54 coils. Fig. 5 shows the winding, Fig. 1, connected for 12 poles. There are 18 groups of 2 coils each and 18 groups of 1 coil each, making a total of 36 groups and 54 coils.

Of course all these connections would not normally operate at the same voltage, nor would the horsepower developed be the same, and the speed would vary inversely as the number of poles. Assuming, for example, that the motor was 100-hp. 60-cycle three-phase 440-volts and run at 1160 r.p.m. on the 6-pole connection, the characteristics for the other connections are shown in Table I. Three-phase is assumed throughout.

TABLE I. CHARACTERISTICS OF A THREE-PHASE MOTOR CONNECTED AS IN FIGS. 1 TO 5

| Poles | H.P. | Voltage | R.P.M. | Connection |
|---|---|---|---|---|
| 6 | 100 | 440 | 1,160 | Fig. 1 |
| 4 | 110 | 484 | 1,750 | Fig. 2 |
| 8 | 86 | 375 | 860 | Fig. 3 |
| 10 | 68 | 300 | 690 | Fig. 4 |
| 12 | 50 | 220 | 580 | Fig. 5 |

The only commercial voltages in Table I are the first and last, 440 and 220. To operate the motor on the other connections would require special taps from the transformer, unless some other change could be made in the motor's winding at the same time that the number of poles was changed. For example, the 8-pole connection requires 375 volts. If it so happened that the 6-pole motor was connected in parallel star, then the 8-pole motor could be connected series delta, which would be the same thing as operating the motor on a voltage in the ratio of 1.73 to 2 or $\frac{375 \times 2}{1.73} = 434$, which is approximately the voltage required.

Table I of horsepowers and normal voltages is figured by taking account of the speed and of the chord factor in the following way:

One of the functions of the winding is to be acted upon by the rotating magnetic field and to actually generate a counter-electromotive force which is opposed to and almost equal to the applied line voltage. If, then, in reconnecting for a different number of poles, the assumption is made that the magnetic field in the teeth and air gap remains at a constant value irrespective of the connections, it is at once evident that the generated electromotive force, and consequently the applied line voltage, should vary directly as the speed of the rotating magnetic field, which is practically the same as the revolutions per minute of the motor at no load. For example, in the case cited in the foregoing, if the normal voltage on the 6-pole connection is 440, everything else being equal, the normal voltage on the 12-pole connection should be 220, since the revolutions per

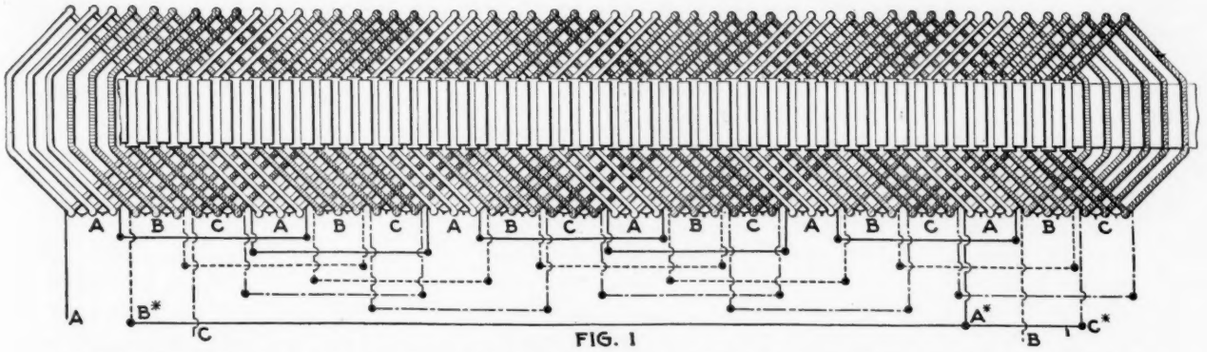



FIG. 1

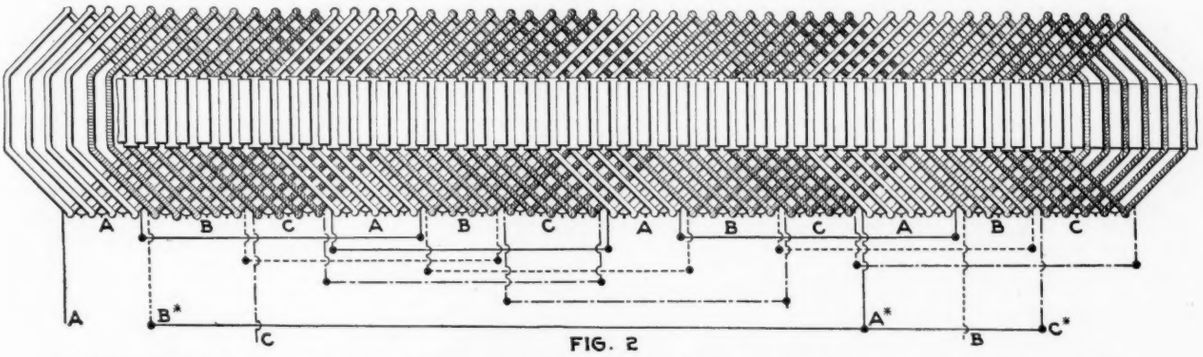



FIG. 2

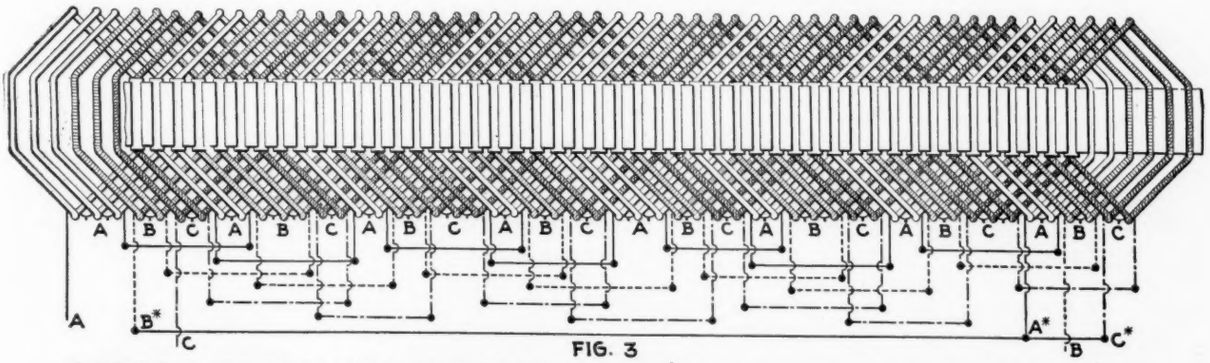



FIG. 3

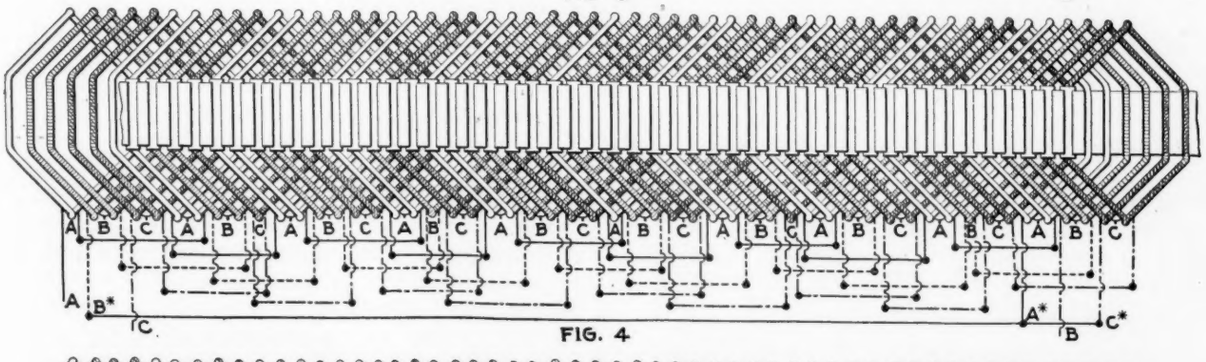



FIG. 4

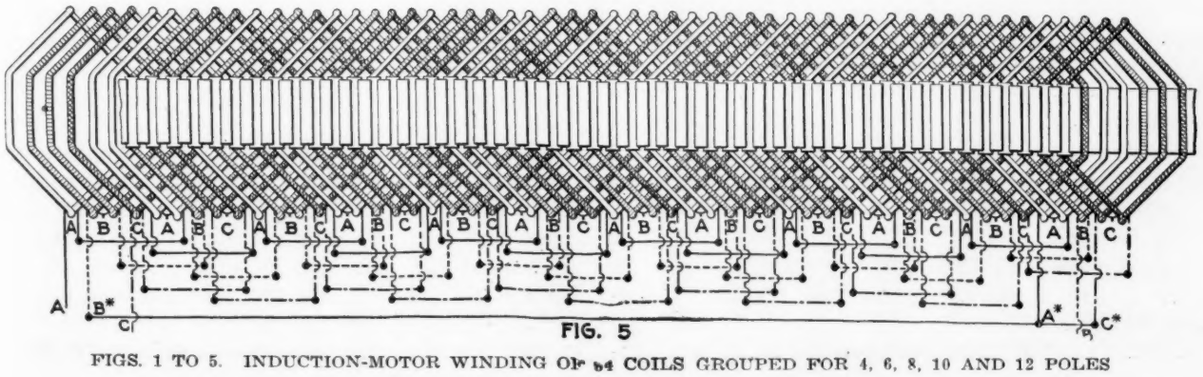



FIG. 5

FIGS. 1 TO 5. INDUCTION-MOTOR WINDING OF 54 COILS GROUPED FOR 4, 6, 8, 10 AND 12 POLES

minute of a 12-pole motor are just one-half those of a 6-pole machine.

Practically, the only condition which enters to change the voltage from varying directly as the speed is the "chord factor," which is due to the throw or pitch of the coil. This was described under "Fractional Pitch Windings" in the July 31, 1917, issue. It will be recalled that this is a factor which reduces the voltage generated in a coil because one side of a coil is not exactly under the center of a north pole when the other side is exactly under the center of a south pole. The numerical value of this factor is expressed as the sine of one-half the electrical angle which is spanned by the coil. It may appear in the example given in Figs. 1 to 5 that the chord factor should remain constant since the physical throw of the coils is unchanged. It should be carried in mind, however, that while the coil spread remains unchanged, the number of poles is changed, consequently the pole arc is changed; hence, the relation of the throw of the coil to the pole arc is different in each case. The foregoing can be best shown by Table II, remembering that the throw of the coils is slots 1 and 7 in all cases.

TABLE II. EFFECTS OF CHANGING THE NUMBER OF POLES IN AN INDUCTION-MOTOR WINDING

| Number of poles | 4 | 6 | 8 | 10 | 12 |
|---|---|---|---|---|---|
| Throw of coil | 1-7 | 1-7 | 1-7 | 1-7 | 1-7 |
| Slots spanned by coil | 6 | 6 | 6 | 6 | 6 |
| Number of slots equivalent to 180 electrical degrees = $\frac{54}{\text{No. of poles}}$ | 13.5 | 9 | 6.75 | 5.4 | 4.5 |
| Electrical degrees represented by six slots | 80 | 120 | 160 | 200 | 240 |
| Sine of half the electrical angle covered by the coil throw or pitch = chord factor | 0.64 | 0.866 | 0.99 | 0.99 | 0.866 |

Table II indicates that the normal 6-pole voltage of 440 must be modified by two factors to find its value for other speeds. These factors and their results are combined in Table III.

On first comparison of Tables II and III it seems peculiar that the 4-pole connection having the lowest chord factor, which is 0.64, operates at 484 volts, which is the highest voltage, while the 8- and 10-pole connections, having a high chord factor of 0.99, operate at 375 and 300 volts respectively. It must be remembered that the speed at which the magnetic field is rotating comes into effect and changes the result of the chord factor. Throughout this series of articles we have considered the induction motor as being an alternating-current generator, generating the counter-electromotive force, or back voltage. Hence, in this case, the assumption has been made that the magnetic field in the air gap remains the same in density for all these connections, and when connected for 4-pole this field will rotate twice as fast as when connected for 8-pole, and thus generate twice as much voltage. This is the reason that the two factors, one due to changing the speed of the field and the other due to changing the throw of the coil, are introduced, as shown in Table III. The product of these two factors governs the voltage which must be applied to the windings to give normal operation.

TABLE III. FACTORS, DUE TO CHANGE IN NUMBER OF POLES, MODIFYING INDUCTION-MOTOR VOLTAGE

| Number of poles | 4 | 6 | 8 | 10 | 12 |
|---|---|---|---|---|---|
| Factor for changing voltage on account of changing speed | 1.5 | 1 | 0.75 | 0.60 | 0.50 |
| Factor for changing voltage on account of change in chord factor = chord factor for new No. of poles ÷ 6-pole chord factor | 0.74 | 1 | 1.14 | 1.14 | 1 |
| Product of Nos. 2 and 3 | 1.11 | 1 | 0.855 | 0.685 | 0.50 |
| Resulting voltage = (440 × No. 4) | 484 | 440 | 375 | 300 | 220 |

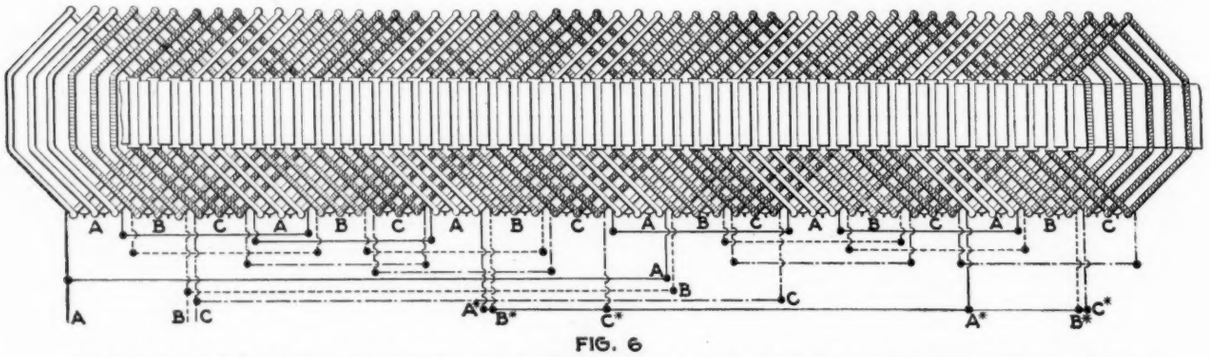



FIG. 6

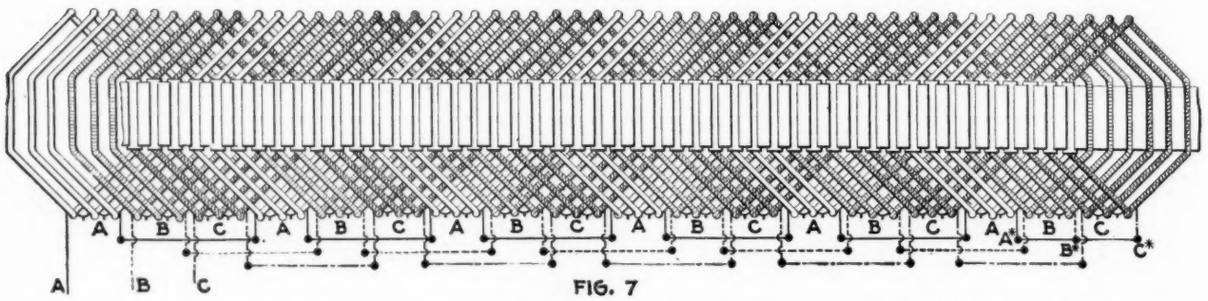



FIG. 7

FIGS. 6 AND 7. INDUCTION-MOTOR WINDING OF 54 COILS GROUPED FOR 6 AND 12 POLES

Fig. 6—Two-parallel-star, connected, 6-pole winding. Fig. 7—Same winding as in Fig. 6 reconnected series-star, consequent pole, for 12 poles.

Table III determines the value of the proper voltage for the new connections as given in Table I. The horsepower is determined just as if it were an alternating-current generator by taking the product of the volts × amperes × 1.73 × power factor and dividing by 746. The cross-section of the copper has not been changed, hence the amperes remain constant. The power factor is assumed the same, although it will be somewhat

higher on high speeds and lower on low speeds. Therefore, the output in horsepower will vary as the voltage, assuming 100 hp. at 440 volts. The horsepower for the new connections is figured in this manner, as given in Table I. Some general observations might be made about the examples chosen in this article: First, the question of starting torque or maximum torque required, or the saturation of the core when connecting for higher speeds might require a voltage somewhat higher or lower than Table I; second, as pointed out in the article in the July 31, 1917, issue of *Power*, on fractional-pitch windings it is not wise, in general, to chord up a coil so far that the chord factor is less than 0.707, which means that the coils span only halfway from the center of a north to the center of a south pole. The reason for this will be shown in the next article by plotting the shape of the magnetic field set up by windings having different coil pitches. For this reason the 4-pole connection, as shown and discussed in this article, should be avoided in practice, but the 6-, 8-, 10- and 12-pole connections would be satisfactory if the proper operating voltage could be secured.

From the foregoing it may be seen that there are three factors to be taken care of in changing the number of poles. These are:

First, if the new speed is to be higher than the original speed, the peripheral speed should not be allowed to exceed 7500 to 8000 ft. This figure is the diameter of the rotor in feet $\times$ 3.14 $\times$ revolutions per minute.

Second, the chord factor of the winding.

Third, the phase-insulation coils should be shifted so as to come at the beginning and ending of the new pole phase groups, as discussed in the article on "Phase Insulation," *Power*, July 31, 1917.

Sometimes, when a winding is connected in parallel star it is possible to reconnect it in series star with consequent poles, as explained in the Mar. 20, 1917, issue of *Power*, and have the motor operate at one-half its original speed. This reconnection is shown in Figs. 6 and 7. Conversely, if the motor was originally connected for series star, it might be reconnected for parallel star and operate at double speed if the motor would stand up mechanically. The counter-electromotive force generated by the consequent-pole connection is only 86.6 per cent. as much as with the salient-pole connection, which means that if the motor was run on normal rated voltage on the consequent-pole connection it would operate as if it had an overvoltage of $\frac{100}{0.866} - 100 = 15$ per cent. Such a reconnection should not be attempted if the throw of the coils is exactly or nearly full pitch for the high speed. The reason for this will be explained in a future article.

The effect of chording the coils or making the throw less than full-pole pitch, as in Figs. 6 and 7, brings out the point that it is often possible in reconnecting a winding to raise the side of all the coils lying in the top of the slots, and to spring the coils one or two slots longer or shorter and thus help out materially on the operating conditions after the change is made. For example, in Fig. 7, if the coils are raised and wound in slots 1 and 6 instead of 1 and 7, the new chord factor would be sine one-half of $\frac{5}{4.5} \times 180$ deg. $= 200$ deg., or 0.98 instead of 0.866. The winding connected, as shown in Fig. 7, would then operate as if on 102 per cent. of normal voltage instead of 115 per cent., which would have cut down the iron losses and improved the power factor.

In the next article a graphical explanation will be given of the effect of chord factor and reconnecting for a different number of poles. This will be shown by plotting the shape of the magnetic field set up by a three-phase winding connected for different numbers of poles and whose coils have different pitches. It will show the magnetic conditions inside the motor which give rise to the practical results discussed in this article. As is the case throughout this series no attempt is made to give actual diagrams for all possible changes of poles, but an effort is made to make plain what is physically happening inside the motor in such a way that the practical man may judge for himself the possibility and advisability of any suggested change in connections.

## Coal-Pit-Mouth Electric Generation

A burning question of these fuel-short and freight-congested times is the feasibility of burning low-grade fuel at coal mines and delivering electric current to remote markets, instead of transporting the coal to plants near the market for current. As practiced now, coal is loaded on cars needed for other freight, hauled by burning a considerable percentage of it in locomotives, also urgently needed for other service, manned by a labor-short craft, delivered to a city where smoke and dirt are "all sorts of objectionable" and where even the disposition of ashes is a serious problem. What absurdity! Those living in some future period will perhaps wonder what manner of men—engineers—lived in what we now call the "advanced age."

For a long time we have been using pipe lines hundreds of miles long, with relay pumping stations, to handle crude oil from the producing fields to the refineries. The oil men seem to have gone the electricians one better and put it over years in advance.

## Protest Power Company Rule

It is becoming the practice of electric-light companies to compel new customers to pay the cost of service connections. According to the *Review*, of East Liverpool, Ohio, the Ohio River Power Co. has adopted such a rule, and the taxpayers and citizens have circulated a petition to be presented to the city council as a protest against this extra charge and to ask the council to use its power to have this ruling discontinued. The company specifies that any person desiring to use electrical currents made by the Ohio River Power Co. shall pay all cost in connection with their lines (this includes time and material) the same to become the property of the company. The petition goes on to state that it is a rule in all cities that the power company shall connect any residence or factory within a reasonable distance of their line free of charge.

The citizens of East Liverpool do not see why they should pay for the installation of connecting line work to their property and then have it become the property of the power company.

# Unpreventable Losses in Coal Combustion Under Boilers

By HAYLETT O'NEILL

*Calculations show the relative magnitude of the various unavoidable losses in the combustion of coal under boilers. A number of charts to assist in making these calculations accompany the article.*

IT NEVER is possible in the ordinary boiler furnace to transform the total heat units in the coal, as determined by the calorimeter, into equivalent heat of the steam. It is the purpose of this article to show the effect of these losses on the ultimate value of coal for steaming purposes. The necessary losses are due to the following causes:

1. To heating the theoretical quantity of air required for combustion from the outside-air temperature to the uptake-gas temperature.

2. To heating the combustible from the outside-air temperature to the temperature of the exit gases.

3. To evaporating and superheating the moisture in the coal from the outside-air temperature to the boiler temperature.

4. To evaporating and superheating the moisture

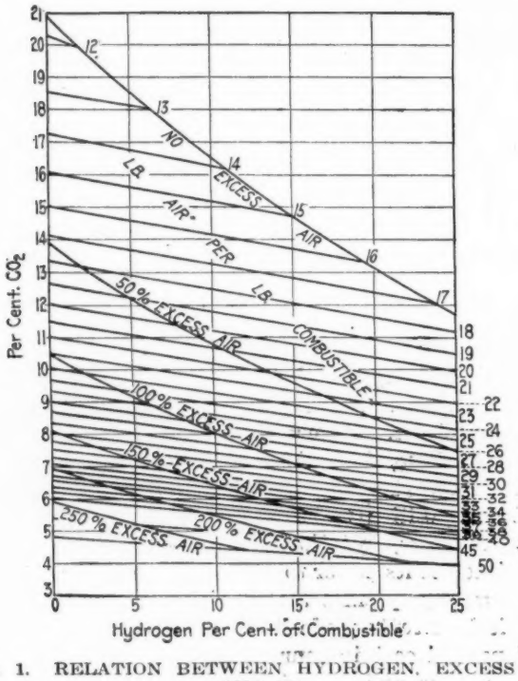



FIG. 1. RELATION BETWEEN HYDROGEN, EXCESS AIR AND $CO_2$

formed by burning hydrogen at outside temperature to the temperature of the exit gases.

5. To heating the moisture in the theoretical amount of air required for combustion, from the outside temperature to the temperature of the exit gases.

In addition there are other losses practically necessary and due to the following causes:

6. To sensible heat in the refuse to the ashpit with a practical minimum percentage of combustible.

7. To unconsumed combustible in the ash with a practical minimum percentage of combustible.

The effect of climate is obvious, and there will be

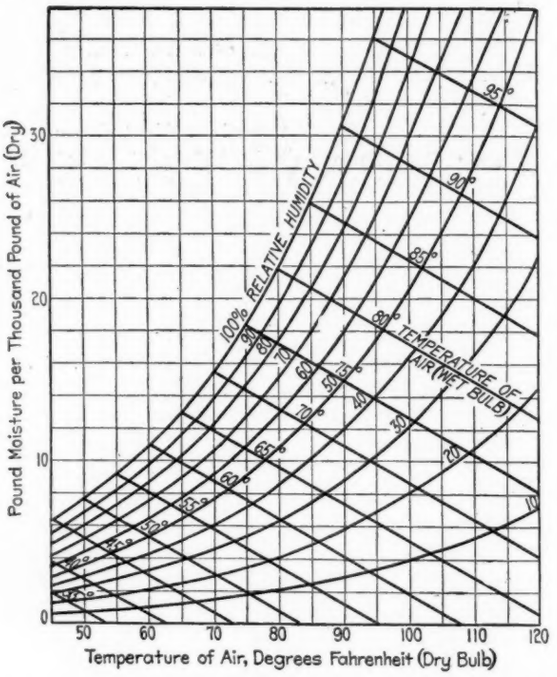

Pound Moisture per Thousand Pound of Air (Dry)
Temperature of Air, Degrees Fahrenheit (Dry Bulb)
100% RELATIVE HUMIDITY
TEMPERATURE OF AIR (WET BULB)

FIG. 2. RATIO OF MOISTURE TO DRY AIR FOR VARIOUS HUMIDITIES

greater necessary losses in winter than in summer. For example, assume:

1. Boiler pressure, lb. abs., 165.
2. Boiler-water temperature, deg. F., 366.
3. Outside-air temperature, deg. F., 70.
4. Relative humidity, per cent., 70.
5. Moisture in coal, per cent., 2.
6. Hydrogen in coal, per cent., 5.
7. Practical minimum combustible in ash, per cent., 25.
8. Temperature of ash, deg. F., 1800.
9. Ash in coal, per cent., 6.
10. B.t.u. (dry), per lb., 14,500.
11. Specific heat of refuse and coal, B.t.u., 0.2.
12. Mean specific heat of vapor in atmosphere, B.t.u., 0.46.
13. Dry coal = ash + hydrogen + carbon. This is approximately correct for high-grade Eastern coals—that is, neglecting the effect of sulphur, nitrogen and oxygen.
14. Specific heat of air, B.t.u., 0.2375.

Fig. 1 shows the relationship between percentage of $CO_2$, excess air, and hydrogen contained in the fuel, and the pounds of air per pound of combustible. For average good-grade coal the percentage of hydrogen is about 5. Referring to Fig. 1, with no excess air

and 5 per cent. hydrogen, the pounds of air per pound of combustible equal 12.7.

The losses then are as follows:

1. Due to heating theoretical air required:

Air required per pound of coal, $(1 - 0.06)12.7 =$ 11.92 lb.

Heat loss per pound of coal, $0.2375 \times 11.92 \times (366 - 70) =$ 839 B.t.u.

2. Due to evaporating and superheating moisture in coal[1] (Values from Marks and Dans' Steam Tables):

$H$ at 14.7 lb. abs. and 366 deg. F. = 1223 B.t.u.

$h$ at 70 deg. F. = 38 B.t.u.

Heat loss, $0.02 \times (1223 - 38) =$ 24 B.t.u.

3. Due to heating combustible:

Heat loss, $(1 - 0.06) \times 0.2 \times (366 - 70) =$ 56 B.t.u.

4. Due to evaporating and superheating moisture formed by burning hydrogen:

Atomic weight of $H = 1$, atomic weight of $O = 16$.

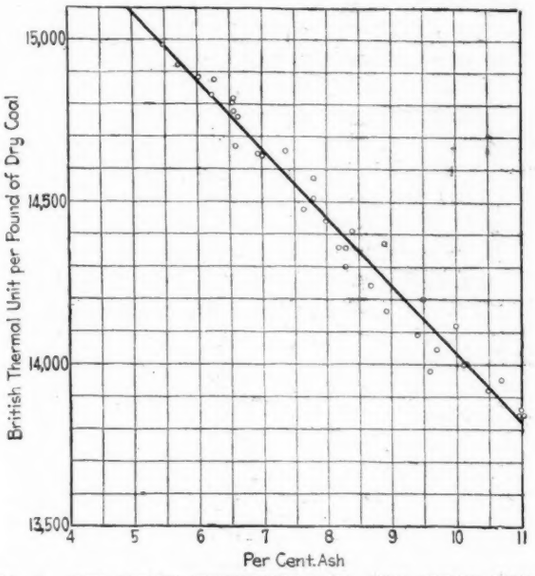



FIG. 3. RELATION BETWEEN ASH AND HEAT VALUE

Pounds of vapor per pound of hydrogen, $\frac{2 + 16}{2} = 9$.

Heat loss, $9 \times 0.05 \times (1223 - 38) =$ 533 B.t.u.

Fig. 2 shows the ratio of moisture to dry air for various relative humidities at different air temperatures, as determined by the ordinary dry-bulb thermometer. With 70 deg. F. air temperature and 70 per cent. relative humidity, the moisture per pound of dry air equals 0.0108 pound

5. Due to heating moisture in air:

Heat loss $= 0.0108 \times 11.92 \times 0.46 \times (366 - 70) =$ 17 B.t.u.

Total heat loss $= 839 + 24 + 56 + 533 + 17 =$ 1469 B.t.u.

From this should be deducted loss due to heating the oxygen required for the combustion of the hydrogen that has been duplicated.

Pounds oxygen per pound of hydrogen, 8.

Heat loss, $0.05 \times 8 \times 0.2375 \times (366 - 70) =$ 29 B.t.u.

Heat loss, net total, $1469 - 29 =$ 1440 B.t.u.

Maximum possible efficiency $= \frac{14,500 - 1440}{14,500} =$ 90 per cent.

6. Loss due to sensible heat in refuse:

$$\frac{0.06}{1 - 25} \times 0.2 \times (1800 - 70) = 28 \text{ B.t.u.}$$

7. Loss due to unconsumed combustible in refuse:

$$\frac{0.25(0.06)}{1 - 25} \times 14,610 = 292 \text{ B.t.u.}$$

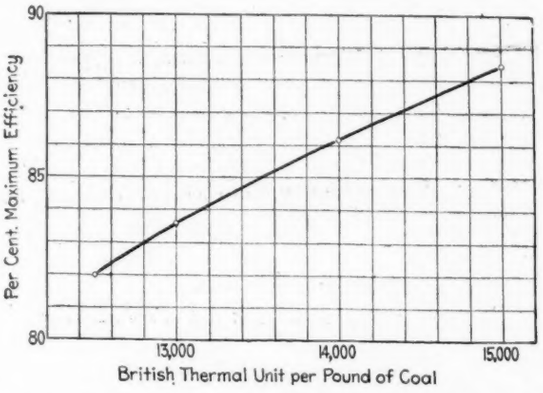



FIG. 4. THEORETICAL THERMAL EFFICIENCY WITH WEST VIRGINIA COAL

Total refuse losses = 320 B.t.u.

Total, all losses = 1763 B.t.u.

Practical ideal efficiency $= \frac{14,500 - 1763}{14,500} =$ 88 per cent.

1. Heat loss on account of warming air:

$$\frac{12.7 \times 296 \times 0.2375(100 \textit{ per cent. ash})}{100} = 8.94 \text{ B.t.u. } (100 \textit{ per cent. ash})$$

2. Heat loss on account of heating combustible:

$$\frac{0.2 \times 296 \times (100 \textit{ per cent. ash})}{100} = 0.5920 \text{ B.t.u. } (100 \textit{ per cent. ash})$$

3. Heat loss on account of moisture in coal:

$$\frac{\textit{Per cent. moisture}}{100} \times 1185 = 11.85 \times \textit{per cent. moisture;}$$

assume this to be 1 per cent., or 12 B.t.u. constant.

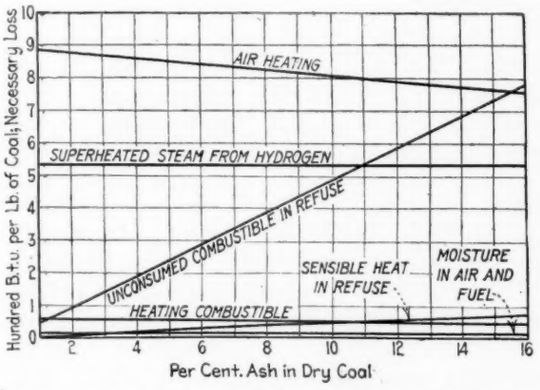

Hundred B.t.u. per Lb. of Coal; Necessary Loss
AIR HEATING
SUPERHEATED STEAM FROM HYDROGEN
UNCONSUMED COMBUSTIBLE IN REFUSE
SENSIBLE HEAT IN REFUSE
MOISTURE IN AIR AND FUEL
HEATING COMBUSTIBLE
Per Cent. Ash in Dry Coal

FIG. 5. SEPARATE AND TOTAL NECESSARY LOSSES

4. Heat loss on account of hydrogen = 533 B.t.u.; assume 5 per cent. $H$.

5. Heat loss on account of moisture in air = 17 B.t.u.; assume this to be constant.

6. Heat loss on account of sensible heat refuse:

$$\frac{\textit{Per cent. ash}}{0.75} \times 0.2 \times 1730 = 4.62 \times \textit{per cent. ash;}$$

assuming 25 per cent. combustible in refuse.

7. Heat loss on account of unconsumed combustible in refuse:

$$\frac{25}{75} \times \frac{per\ cent.\ ash}{100} \times 14{,}610 = 48.7 \times per\ cent.\ ash;$$

assuming 25 per cent. combustible refuse.

Summing up all losses, we have:

Necessary losses in B.t.u. = 1486 + 43.8 × per cent. ash.

For good West Virginia coal, analyses taken from a bulletin of the United States Geological Survey show the following relationship between percentage of ash and heat content:

B.t.u. per pound dry is 16,130 — 210 × per cent. ash. This is shown graphically in Fig. 3.

$$Maximum\ efficiency = \frac{B.t.u. - (1486 + 43.8\ per\ cent.\ ash)}{B.t.u.}$$

Substituting ash in terms of B.t.u.,

$$Maximum\ efficiency = \frac{1.208\ B.t.u. - 4832}{B.t.u.}$$

This relationship is shown in Fig. 4.

Fig. 5 shows the separate and total necessary losses as calculated.

## Cleaning a Condenser With Muriatic Acid

BY D. C. MCKEEHAN

The writer once took charge of a 500-kw. plant using a 1525-sq.ft. surface condenser containing 875 three-fourths-inch brass tubes. The plant had been in operation only about six months. Mine water containing a high percentage of scale-forming material was used for cooling, and the tubes were rapidly becoming "plugged." The scale was about as hard as gypsum, so that scraping or drilling was both costly and unsatisfactory. Few of the tubes were clear enough so that a light could be seen through them; only a ¼-in. rod could be pushed through quite a number, and dozens were closed completely. This was about the "limit" for condenser operation, particularly for apparatus in use for so short a time. The problem was to get the tubes clean or at least clean enough to maintain a "reasonably good" vacuum. At times a peak load would pull the vacuum from 19 or 20 in. (the best obtainable at light load) to zero and a clattering of the relief valve could be heard. However, zero vacuum was better than exhausting into the atmosphere, for it allowed the hot condensate to be returned to the boilers—when the pump did not balk; besides, the water was better than usual.

To clear the condenser of scale, it was completely filled with muriatic acid and water, about equal parts, acid being poured in about two quarts at a time, then two quarts of water. The cooling-water intake and discharge openings were of course sealed in order to retain the solution, and to prevent pressure suitable vents were provided for the escaping gas. Occasionally, a violent blowing would occur at the vents, due to the acid opening a tube that contained active material, also due to the increased surface acted upon. The solution was allowed to remain in the condenser until bubbling practically ceased, when it was drained into the circulating pump so that the unconsumed acid might remove the scale from it; and at times it was allowed to pass to the spray nozzles to clean them also. The operation usually required about eight hours, and the treatment was applied every month for about a year. Previous to the recent high price of acid the cost was not excessive, all things considered, and the method of procedure adopted was apparently the most economical available. Operating conditions have changed for the better in the last two years, the tubes requiring cleaning at intervals of two or three months only, as a purer cooling water is available and the pond is allowed to cool from 4 p.m. Saturday until 7 a.m. on the following Monday.

In four years we have removed about 400 tubes and given them individual treatment with acid in a trough, and some were set aside for the scale to air-slack. The percentage of tubes discarded owing to acid attacking the metal is negligible, probably not more than ten. Tubes with longitudinal splits, possibly due to expanding scale inside, number only eight. The corset-lacing packing at tube ends was badly eaten at the end of the first year.

The water-jacket space of the vacuum pump was also cleared of scale by the acid treatment. Then a peculiar turbine vibration suggested that scale or sediment had accumulated on the bottom of the rotor while standing idle. Examination was impossible except at the exhaust end, but these buckets showed a slight coating of dirt and scale. The turbine casing was half filled with a dilute solution of acid and the shaft then turned slowly with a bar. The usual boiling and bubbling sounds were heard inside and rank odors were emitted. When drained of acid and put into service, the turbine acted very well; a subsequent test showed better results, and there was no injurious action on the blading. Kerosene, previously tried, failed to clean the turbine rotor.

## Suggestions on the Management of Boilers

BY L. R. HOFFMAN

Assuming a properly installed and equipped plant, the attendant should be a sober, industrious man with enough intelligence to realize the responsibility of his position; he should be well paid and should give heed to the following:

Boilers should be kept free from scale, sludge and soot, inside and outside; frequency of cleaning depends on conditions, but they must be clean at any cost. At least one gage of water should be blown out of a boiler daily, and more as conditions demand. Pop valves should be lifted from their seats at least once a day, and they should be kept clean and free inside and out. Water columns should be blown out at least once a day, noting that the water returns quickly and does not stand dead still; the water should rise and fall gently in the glass at all times. Try-cocks should be blown at least once a day and kept free and clean.

If only one boiler is in use, two steam gages should show the pressure, and when they do not agree they should be inspected and adjusted at once. Sudden contraction and expansion of the metal of a boiler saps its strength. This should be avoided by keeping the feed water going into the boiler steadily, holding the water level near the same place when this is possible.

# Government Control of Water Power and Electrical Distribution Abroad

By L. W. SCHMIDT

*The writer gives an outline of what has been done in European countries to regulate the production and distribution of electrical energy. Indications seem to point in the direction of increased governmental control of electrical-power production and consumption.*

THERE is today possibly no country in the world that has not attempted in one way or another to regulate the production and distribution of electrical power. As to the control of power production, a difference is made as a rule between power generated by steam and hydro-electric power. The reason for this is that while the former has to be regarded more or less as an industrial product, power generated by water is a natural product and therefore more or less the property of the nation as a whole. The systems that have been used for the control of power production and distribution differ very much in each country. Governmental control, where it exerts itself, may begin at the fountain of production, it may be confined to a regulation of the means of distribution, or, finally, it may attempt to control the price of power when sold to the consumer. There are examples of all kinds of regulations among the laws and administrative orders issued in one or another country of the world.

## Early Laws Dealing With Electrical Power

The juridical conception of electrical power in the early days of electrical-power control was that of a merchandise produced by a manufacturer and sold to a consumer. Unfortunately for the law makers, this sort of merchandise embodied certain characteristics which necessitated a distribution and consumption different from that of other merchandise sold. The production and distribution of coal gas seemed to be the only precedent. Laws regulating the production and distribution of electrical power, therefore, were framed after the example of the laws dealing with the sale and production of coal gas. This explains some of the measures found in many of the earlier European laws dealing with the control of electric energy, which for a long time hindered the progress of the industry until they were removed by later legislation.

When governments finally came to formulate a policy as to their dealings with the new power, their first desire was to protect the citizen against the real or imagined dangers connected with its application. The outcome of this generally has been laws dealing principally with the distribution of electrical power. They affect the right-of-way of electrical transmission lines and deal with such questions as protection of private property by falling wires, etc. With the progress made in overland transmission, many of these laws have been strengthened materially, especially as to their safety provisions, and they form today an essential part of the regulations controlling electrical-power distribution all over the world. With the coming of the public utility into the field of electrical enterprise, these laws have been used frequently in support of the public utility against the private electrical enterprise, and it is this side of their application that is of especial interest to the power industry.

This, for instance, is done by the French law of July 15, 1906, regulating electrical enterprise. This law, while providing for the right-of-way for electrical distribution, differentiates between the undertaking having the character of a public utility and such lacking this quality. Each kind of enterprise can obtain a local monopoly as to electric lighting, but only the public utility can claim the additional right of eminent domain. No monopoly is given to either with reference to the production and sale of power only. To prevent the private enterprise from enroaching upon the sales field and thus impeding the action of the public utility, an act has been passed which amends the law by giving a preferential right-of-way to the high-tension transmission lines of the public utilities and semipublic utilities against the ordinary commercial enterprise.

## Switzerland Encourages Use of National Water Powers

The same tendency to favor special groups of enterprises is shown in Switzerland, where preferential right-of-way is given to the transmission lines of hydro-electric power stations with the object of encouraging the use of the national water powers for power generation. This Swiss law deals also with transmission lines in general.

Of late Prussia has made an entirely new use of its powers to regulate the transmission. Prussia formerly followed the principle of free development of electrical enterprise, reserving for the government only the right to control the conduct of high-tension transmission lines for which, to use the right-of-way, under the Prussian law, a special permission is needed. The result of this policy has been a rather irregular development of power distribution in Prussia, which often leaves out districts in the immediate neighborhood of the central stations in favor of others farther removed but promising a better financial return. In the absence of a special law Prussia has now decided to use its administrative powers to force the central stations to serve not only the districts where great profits can be obtained, but also those which are less promising but possibly not less deserving. The way selected for this purpose is surprisingly simple.

## Right-of-Way for Prussian Transmission Lines

The usual procedure to obtain the right-of-way essential for the conduct of transmission lines is that of application to the provincial authorities. Since 1914 the Ministry of Public Works, which has the direct control of all matters of this description, has decreed that these applications can no longer be passed upon by the provincial presidents, but must be referred to

the Minister of Public Works. All applications have to be accompanied by full explanations as to the intended extensions of the installation and the present activity of the central station. Permission for further extensions will be granted only if in line with the special policy followed by the Ministry of Public Works. The Ministry may make its permission dependent upon the condition that the central station, while making the extension, will also make extensions to districts needing supply.

The Netherlands, which has suffered from a similar development of its national electrical supply, has embodied into its new law for the control of electrical enterprise a paragraph reserving to the Crown the right to stipulate the extension or the limits of the distribution field of any licensed electric undertaking. This is done to prevent discrimination in favor or to the disadvantage of certain parts of the country or certain groups of likely subscribers. The law also gives to the government the right to decree the date at which all the districts comprised in the license must be fully connected.

Generally speaking, it appears that the regulation of electrical enterprise by simply exerting control over the distribution of power has not been accompanied by very satisfactory results from the national point of view. The governments realized, in fact, very early the great advantages which industry and public life were destined to derive from the new power. A change took place in the form of governmental control. While all the earlier laws rather inclined toward restricting the use of electricity, parliaments now began to enact measures with a view to aid its expansion. Laws were made giving electrical enterprises certain privileges similar to those enjoyed by railroads and other enterprises of that kind. A series of public-utility laws were made which placed the electrical-power industry in a special, favored position in comparison with other national industries. At the same time a tendency was shown to protect public electric undertakings against destructive competition. Laws, therefore, were passed regulating electrical concessions. Most of the big electrical enterprises having the municipal or public-utility character of today were created during the last twenty years of the past century.

### England Took Lead in Electrical Power Legislation

The lead in this kind of legislation doubtless was taken by England, which promulgated her first law regulating the generation and distribution of electrical energy during the year 1882. This law gave the control of electrical enterprise in England into the hands of the Board of Trade, which was and still is empowered to issue licenses to municipalities, companies and individuals wishing to operate electrical undertakings. Today the license is granted as a rule after consulting the local authorities, but the board can act without such consultation. According to the law of 1882 the authorities of the locality served had the right to acquire the enterprise after a period of 21 years at 10 per cent. of its value. As it was found that the shortness of this period tended to discourage private enterprise, it was extended to 42 years by the Act of 1888. The Board of Trade exerts considerable powers of control over all electrical undertakings in England, of which the most prominent is the right to review rates. Under a special act of Parliament of 1909 central stations in Great Britain have the right of eminent domain for the conduct of transmission lines and other purposes.

This law of 1882 is doubtless the fundamental law dealing with electrical enterprise today in the whole world. It was the first law that attempted to deal with the production and distribution of electrical power on the basis of a progressive national policy, and it has been copied later in part or in whole not only by most of the British colonies, but practically by all countries of the world. Its licensing provisions are recognized today to be an essential part of all legislation endeavoring to produce the best application of electrical power for the good of all, and there is hardly an agreement made between a public body and a private enterprise for the operation of a public utility in which there is not embodied the right of the licensor to acquire the property from the licensee after the expiration of a certain period with or without compensation to the licensee. As to the right of reviewing rates this is today recognized everywhere.

### British Board of Trade Favors Municipal Enterprise

While there is nothing in the English law compelling the Board of Trade to follow a certain policy in the issue of licenses to electrical enterprises, it appears from the actions of the board that it has been rather inclined to favor the municipal enterprise. Competition has been allowed to grow in the operating fields of private enterprise, but the municipal enterprise as a rule has been protected against the encroachment of private stations. But allowing even for this preference shown to the public undertaking, it appears that in principle at least the right of free competition has been upheld in England. This right seems to have found its widest application in the policy followed by Italy in dealing with electrical undertakings. In that country electrical enterprises have to obtain a license before beginning operation. This license, however, is obtained apparently without much difficulty, and the result is that there is hardly a city of any size where there are not two or even more electrical stations competing for business.

While competition, therefore, seems to have been held essential to rapid electrical-power development during the last twenty years, it seems that this policy is slowly changing in favor of consolidation of power production with a view to securing a cheaper and more even supply of power over the whole country.

This development has been favored by two considerations. The first has been the increasing use made of the water powers for electric-power generation and the necessity of passing laws for that purpose; the second, the growing demand by industrial and other consumers for the supply of power.

Before considering this last and most recent phase in the development of national power control, the following few examples of legislation dealing with the use of natural water powers in Europe may be given. The Norwegian law recognizes the right of the nation to regulate the use of the water powers of the country, but makes certain exceptions as to such uses of water

as do not encroach on the public interest, do not increase or decrease the sea level of inland waters or produce powers above 368 kw. Application for the use of water power can be acted upon by the king provided the withdrawal of water does not exceed 7360 kw. If it is contemplated to use more power, permission can be obtained only by special act of the Storthing. The law does not exclude foreigners from the use of the water powers, but prescribes that concessions given to foreign enterprises as a rule shall not run for longer than sixty years. The Storthing is empowered to extend the duration for another ten years. In every case the nation reserves the right to acquire the property of the licensee after forty years of operation. No payment need be made in such a case where the acquisition takes place after fifty years of operation. The use of water power is dependent upon the payment of a license fee.

### The French Water-Power Law

Very similar to the Norwegian water-power law is that of France. This law demands in the case of developments of less than 200 kw. a simple governmental authorization which is issued, as a rule, without much trouble to the applicant. Developments of 200 to 5000 kw. require a special governmental decree, while higher developments can be carried out only under a special law. The maximum duration of an authorization is 75 years, but the concession may be extended for another ten years if no new concession has been granted five years before the expiration of the original grant. The government reserves the right of expropriation after a period of fifteen years' duration of the grant if such action is in the public interest.

Similar action for the protection of the natural power resources has been taken by most of the South American governments. The water-power law of New Zealand represents today the final stage in this development reached so far by reserving the right of all hydro-electric development to the nation. The Dominion is now developing the most promising power sites under national management.

So far Europe does not seem to be ready to go all the way in the direction of public ownership of national power production. Nevertheless, it becomes now increasingly clear that future legislation in Europe destined to deal with the problem of power production and distribution will be vastly different from the policies followed before the war. It is generally held in Europe that electrical-power production has passed the stage of the public utility and reached that of national utility.

### Prussian Government Adopts New Policy

The Prussian government only recently struck out for a new policy in hydro-electric power development by which it enters into direct competition with the existing private and municipal generating stations with the avowed intention finally to take control of the whole power generation in Prussia. So far the scheme provides for a system of interconnected hydro-electric and steam power stations owned by the Prussian government which will cover all of western Prussia from Bremen to the Main. The interesting feature of this scheme is that the different stations have been selected in such a way as to supplement one another. If, as it is expected, the station on the Main should suffer in effectiveness during the months of February and March, its losses can be equalized with the help of the two stations at the Elderthal and the Diementhal reservoir, where sufficient power will be obtainable for this purpose. Another hydro-electric station, according to press reports, is located at Dorverden. This, like the others forementioned, will be connected with the steam-power plant near Hanover, where the great peat coal beds of the neighborhood can be employed as a cheap fuel.

This Prussian system of power supply is continued in the south by a similar development in Bavaria. The center of the Bavarian scheme is the powerful government central station on the Walchensee. For the purpose of this enterprise it is proposed to combine all the power stations existing at present in Bavaria, the new combination to be conducted under governmental control. The Walchensee development will be connected with the most powerful of the other stations, and these together will be the principal sources of electrical power in the kingdom, while the small stations will continue to act merely as distribution stations for the central system. It is expected that such an organization would save approximately 20 per cent. on the present operation expenses, or about $1,000,000 a year.

France also will make a better use of its natural power resources after the war. It appears that so far no special legislation has been passed for this purpose, but a commission has been appointed to inquire into the existing hydro-electric possibilities of the country with a view to early exploitation.

### England Adopts the Most Extensive Scheme

The most extensive scheme for national power control so far developed, however, has been put forward in England. The industrial reorientation in England forced by the war has provided for the opportunity also to reorganize the whole system of power supply in that country. According to the present scheme, which was worked out by a combined committee of the Municipal Electrical Association and the Incorporated Association of Electrical Power Companies, it is contemplated to divide England and Scotland into sixteen supply areas. These areas will not be formed by political divisions, but their boundaries will be defined rather by technical considerations so that the best results may be obtained in the distribution of power. In each area the production of power will be concentrated in such a way as to allow the closing down of all the generation stations that are not absolutely essential. The remaining stations will be interconnected to obtain a better equalization of the load over the operating district. It is thought that it may be possible to use most of the existing large power houses. Should additions be necessary, it is proposed that new power houses be erected in neighborhoods where special facilities are offered for their operation.

While all power experts in England seem to agree that the concentration of power generation in the form prescribed by the report finally will be the most satisfactory solution of England's power problems, public opinion is not as unanimous about the recommendation of the committee to exert the same control on power distribution. Most probably this will be left in the hands of the existing enterprises. Estimates seem to show that by reorganizing in this way the production of

electric power, it will be possible for England to effect a saving of approximately 50 per cent. in the cost of electricity to the consumer. All in all about six hundred central stations would be affected by the scheme. The control of the enterprise will be in the hands of a national board of control.

As the existing powers of the Board of Trade will not be sufficient to carry into effect so vast a scheme of electrical organization, it will be necessary to obtain special powers by act of parliament, and the whole enterprise, therefore, will be discussed fully before being actually put into operation.

In Europe the war has been the principal cause of the reforms now contemplated. It is, however, certain that even if the war had not come, steps very soon would have to be taken for a reorganization of the legislation governing electrical-power production and development. The great progress made in the electrometallurgical and the electrochemical industries has widened the application of electrical power in such a way as to necessitate the employment of power which could not be foreseen originally by power experts and law makers. The war now has prepared a fertile ground for a new settlement of the whole question of power control. What will be the solution of the problems raised is still not quite clear. In Europe all indications seem to point in the direction of increased national control of electrical power in all its stages from production to consumption.

## Boiler-Room Gage and Control Board

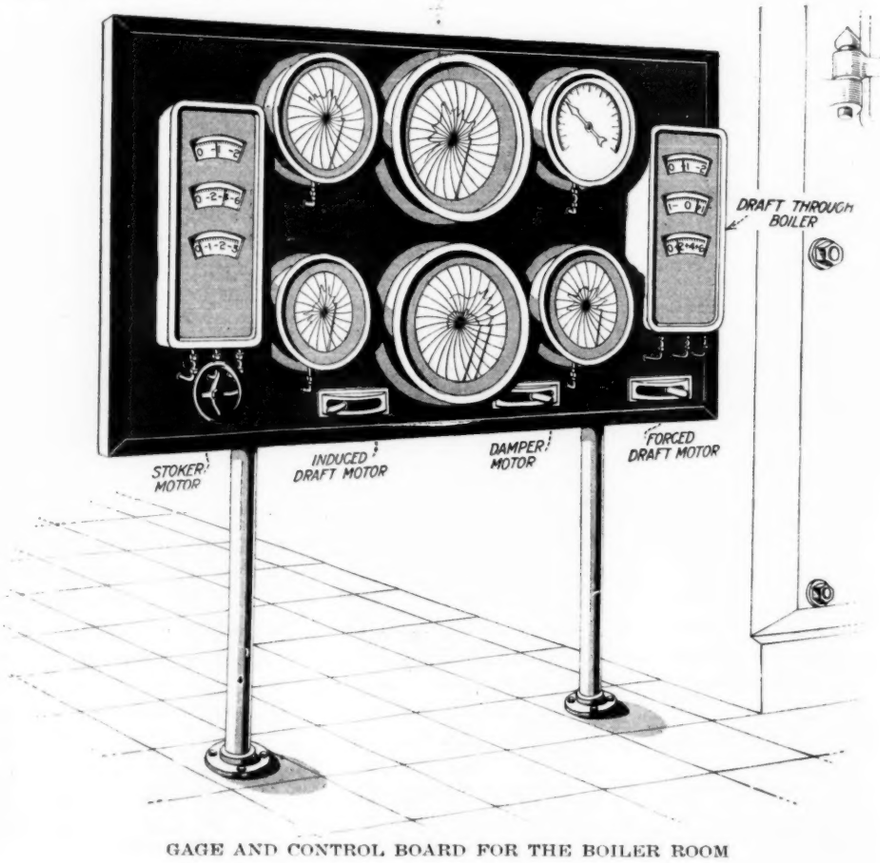
Centralization is the basis of economy in any branch of industry. A machinist would make but little progress in turning out his allotment of work if he were obliged to go from one side of the shop to the other each time he required a tool. In the power plant a fireman will be able to obtain better results from his boilers if the various gages, draft-fan control and other necessary operating devices are placed convenient for observation and manipulation instead of being scattered about the boiler room wherever it is most convenient to place them.

The idea of centralization has been adopted by the Precision Instrument Co., Detroit, Mich., in the design of a boiler-room gage and control board illustrated herewith. The recording gages include a tachometer for recording the speed of the stoker and a steam-flow meter for recording the steam flow in the main steam header leading to the power unit; there is also an indicating steam gage. These are arranged at the upper portion of the board; at the lower end there is a $CO_2$ recorder for furnace gases, a double-pen recording gage for furnace- and chimney-gas temperatures and a recording steam-pressure gage. At the right-hand end of the board there is a three-in-one draft gage that indicates the standard readings of the furnace draft which has a register of from zero to 2 in. of water for the flue; 1 in. vacuum to 1 in. pressure for the combustion chamber and from zero to 6 in. for the ashpit. These readings are shown on the boiler-draft gage beginning at the top of the instrument and reading downward.

At the left of the gage board is another three-in-one draft gage for indicating the draft through the economizer. The top gage is connected to indicate the draft in inches at the chimney, the center one shows the draft through the economizer, and the bottom one the draft at the entrance to the economizer when one is used.

Centralization of the motor control is also taken care of as shown by the handwheel and the switches at the bottom of the gage board. The handwheel at the left controls the rheostat of the motor that operates the stokers. Next to it is a switch for starting and stopping the induced-draft fan motor; the center switch is to control the motor used for opening and closing the main damper in the smoke flue, and the last switch is for controlling the motor that drives the forced-draft fan.

This gage board is supported on standards, and it can be placed at any point in the boiler room where the operator can conveniently get at it for operating the various controls and for reading the various instruments.




GAGE AND CONTROL BOARD FOR THE BOILER ROOM

# The Electrical Study Course—Shunt-Connected Generators

*Explains how an electrical generator builds up its voltage from the small pressure that is generated due to the residual magnetism in the polepieces. The relation that must exist between the field coil and armature connection for the machine to generate normal voltage is also pointed out.*

IN THE previous lesson we considered that the field coils of the generator were excited from an outside source; that is, as in Fig. 1, the field coils are assumed to be connected to some source of electric current, for exciting them, separate from the armature. In alternating-current generators the field coils are always excited from a separate source of direct current, but in direct-current generators the field coils are in almost all cases excited directly from the armature. There are two ways of doing this, one by connecting the field coils directly across the brushes—that is, the field winding is in parallel with the armature, as in Fig. 3—and another by connecting the field coils in series with the armature, as in Fig. 4.

When the field coils and armature are connected in parallel, as in Fig. 3, the machine is known as a shunt-connected generator; when the field coils and armature of a generator are connected in series, as in Fig. 4, it is known as a series machine. The shunt-type machine, or

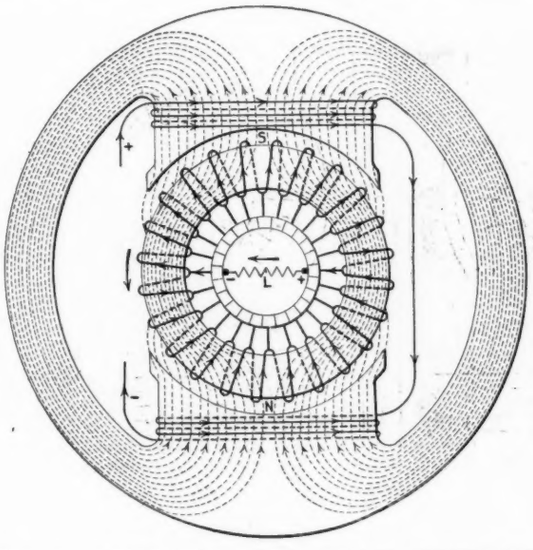



FIG. 1. SEPARATE-EXCITED SHUNT GENERATOR

modifications of it, which will be considered later, is the type that is generally used, the straight series type being seldom used and then in only special cases. To simplify the connection in Fig. 3 and subsequent figures, the commutator will be shown on the outside of the winding and the yoke will be dispensed with.

With the machine that excites its own field coils, the first question that arises is, How does the machine start to generate? If the machine was new and never had been in service before, it would not generate until an electric current had been caused to flow through the field coils to magnetize the polepieces. When the field poles have been magnetized, they will retain a small percentage of the magnetism after the current has ceased to flow through the field coils. This generally

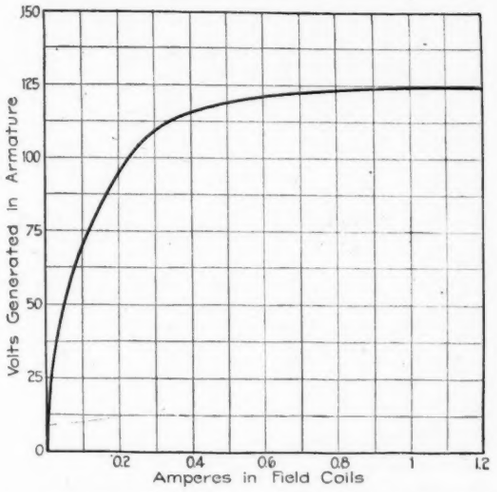



FIG. 2. DIRECT-CURRENT GENERATOR VOLTAGE CURVE

amounts to about 5 per cent. of the normal field magnetism. The magnetic flux which remains in the field poles after the current has ceased to flow in the coils is called the residual magnetism. This residual magnetism is sufficient in a 110-volt machine to cause about 5 or 6 volts to be generated in the armature when running at normal speed and with the field coils disconnected from the armature, as in Fig. 5; in a 220-volt machine, approximately 10 or 12 volts will be generated due to the residual magnetism.

If the field coils are connected across the armature, as in Fig. 3, and the latter revolves in the direction of the curved arrow, a small voltage will be, as pointed out in the foregoing, generated in the armature windings. This small voltage, say 5 volts, will cause a small current to flow through the field windings; if in the proper direction, it will cause the field strength to be increased above that of the residual magnetism.

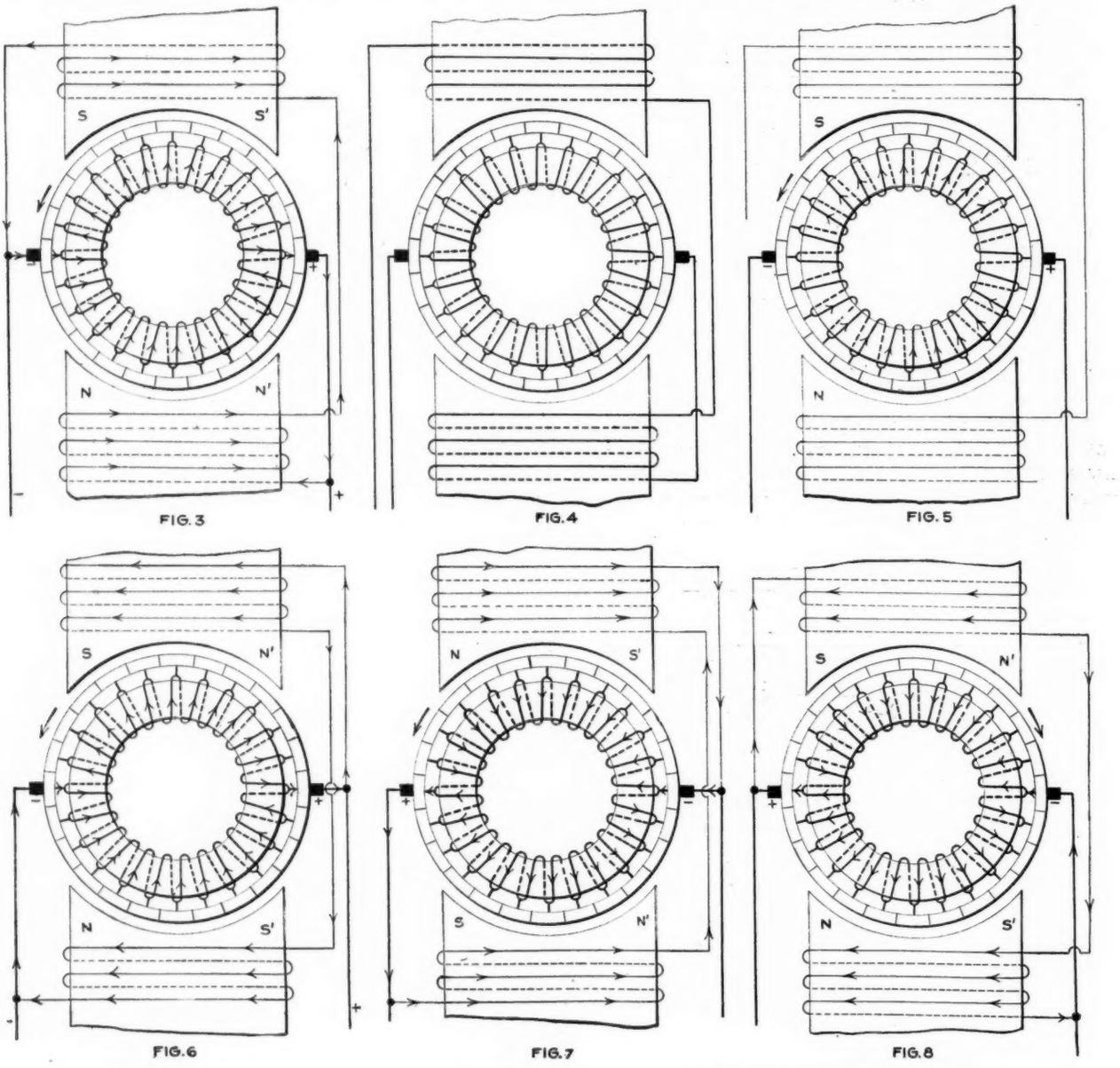
In Fig. 3 the polarity of the residual magnetism is denoted by $N$ and $S$, which will, for the direction that the armature is turning in, cause the right-hand brush to have positive and the left-hand brush negative polarity. This in turn will cause a current to flow through the field coils in the direction indicated by the arrowheads. By applying the rule for the polarity of a coil of wire with an electric current flowing through it, it will be found that the field coils will have a polarity as indicated by $N'$ and $S'$, which will be seen to be the same as the residual magnetism in the polepieces. Consequently the current flowing in the field coils will assist in magnetizing the polepieces, and the small current set up in the field coils by the 5 volts, which we assumed was generated due to the residual magnetism in the polepieces, will increase the field strength; that is, there

will be a greater number of lines of force entering and leaving the armature. The armature will therefore be cutting a greater number of magnetic lines, hence causing the voltage to increase, which in turn will cause the field current to increase, thus bringing about another increase in the field flux and also the voltage in the armature. This process continues until the machine is generating full voltage.

The next question that naturally arises is why this process does not keep on indefinitely and the voltage continue to increase in value. The answer to this is found in the fact that the lines of force in the field poles do not increase in proportion to the current flowing through the coils.

If we were to take a generator with the iron in the magnetic circuit absolutely dead, that is, no residual magnetism in it, and connect a voltmeter across the armature terminal and drive the machine at normal speed, it would be found that the voltmeter would give no reading, indicating that no voltage was being generated. However, if the field coils are connected to a separate source of voltage and a small current caused to flow through the field coils, say 0.2 ampere, we would find that the generator would produce an electromotive force of, say 90 volts. Then if we were to increase the current to 0.4 ampere, it would be found that the voltage may not increase as much for the second 0.2 ampere as it did for the first. This, however, will depend somewhat upon the normal voltage of the machine. In this case assume the normal voltage to be 110 and that when 0.4 ampere was flowing in the field coils, the machine generates 115 volts.

The foregoing is indicated on the curve Fig. 2. Here it is shown that if the field current is increased to 0.6 ampere, the volts will only increase to about 120, and beyond this point if the current is increased to 1.2 amperes, the voltage only increases to 124. For the first 0.6 ampere supplied to the field coils the voltage in-




FIGS. 3 TO 8. DIAGRAMS OF SHUNT-CONNECTED AND SERIES-CONNECTED GENERATORS

creases from 0 to 120, but for the next 0.6 ampere the e.m.f. only increases from 120 to 124, or an increase of 4 volts. The foregoing indicates that the lines of force in the polepieces increase rapidly at first, but as the current in the field coils increases, a condition is reached beyond which increasing the current in the latter will not cause any increase in the lines of force. This condition is called the point of saturation; that is, the iron is saturated with magnetic flux, just the same as a sponge becomes saturated with water.

A fixed relation exists between the connection of the field winding to the armature and the direction of rotation. It has already been shown that the field-coil connections to the armature in Fig. 3 are such that the current flows through them from the armature, in a direction to make the field coils the same polarity as the residual magnetism in the polepieces, thus causing the machine to build up to normal voltage. However, suppose we interchange the field-coil connections as in Fig. 6. In this case the polarity of the field coils, as indicated by $N'$ and $S'$ is opposite to that of the residual magnetism, indicated by $N$ and $S$. Consequently, instead of the small current caused to flow in the field coils by the voltage generated due to the residual flux, increasing the field strength, it has the opposite effect and the machine cannot build up its voltage.

At first thought it may appear that if the polarity of the residual magnetism is reversed, the machine connected as in Fig. 6 could build up. Considering Fig. 7 will show that this is not true. Since the residual magnetism is reversed, as indicated by $N$ and $S$, the voltage generator in the armature is reversed; consequently, the current in the field coils is also reversed, as indicated by the arrowheads. This again brings the polarity of the field coil, as shown by $N'$ and $S'$, opposite to that of the residual flux, and the machine cannot build up. Therefore it is evident that for the direction of rotation shown there is only one way that the field coil can be connected to the armature and have the machine generate, and that is as in Fig. 3.

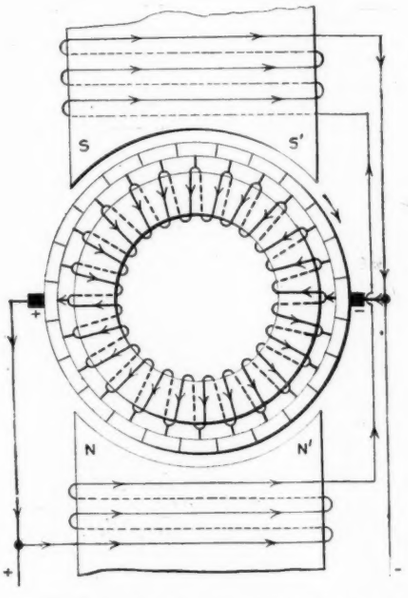



FIG. 9. SHUNT-CONNECTED GENERATOR. SAME AS FIG. 8 WITH FIELD CONNECTIONS INTERCHANGED

If the armature's direction of rotation is reversed, as in Fig. 8, then the field-coil connections to the armature have to be reversed before the machine can build up. Assume the same polarity for the residual magnetism as in Fig. 3; then, since the direction of rotation is reversed in Fig. 8, the voltage generated in the armature winding will be reversed, as indicated by the arrowheads. This voltage will cause a small current to flow through the field coils in a direction as shown, which gives the coils a polarity $N'$ and $S'$ which is opposite to that of the residual flux, and the generator cannot build up to normal voltage.

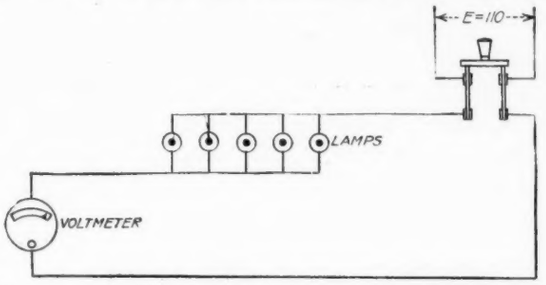



FIG. 10. DIAGRAM OF LAMP BANK CONNECTED IN SERIES WITH A VOLTMETER

To produce a condition where the machine can build up its voltage, it will be necessary to interchange the field connection to the armature terminals, as in Fig. 9. This allows the small voltage due to the residual magnetism to set up in the field coils a current that will give them the same polarity as the residual flux, as shown, and the machine will build up to normal voltage.

The foregoing is an important point to remember when putting into service a new machine or one that has been repaired. After the field poles have been excited by sending a current through the field coils from an outside source, to establish the residual magnetism, if the machine does not build up, then the shunt-field coil connection should be reversed.

One way of knowing when the field coils are connected in the right relation to the armature is as follows: First bring the machine up to normal speed with the field coils disconnected from the armature and note the voltage generated, which should, as pointed out in the foregoing, be about 5 or 6 for a 110-volt machine, 10 or 12 for a 220-volt machine, etc. After doing this connect the field coils to the armature, and if the voltage due to the residual magnetism decreases, the field-coil connections must be reversed for the machine to come up to normal voltage. Further consideration will be given the shunt generator, also the series generator, in the next lesson.

Fig. 1 is similar to the problem given in the last lesson. The two circuits through the armature from the negative brush around to the positive are in parallel, and each path was assumed to have 0.5 ohm resistance. Therefore, the resistance of the armature winding between brushes is one-half that of one path, or $0.5 \div 2 = 0.25$ ohm. The external resistance was assumed to be 4.75 ohms; then the total resistance of the armature and external circuit is $R = 0.25 + 4.75 = 5$ ohms.

When the armature is generated a voltage $E = 150$, the current flowing in the circuit is $I = \frac{E}{R} = \frac{150}{5} = 30$ amperes. This current will divide at the negative brush

and one-half will flow through each of the two circuits in the armature winding. Consequently, each half of the armature winding will supply 15 amperes to the external circuit. The volts drop in the armature equals the joint resistance of the winding times the total current, or $0.25 \times 30 = 7.5$ volts. The volts drop also equals the resistance of one path through the armature winding times the current flowing in this path, or in this case $0.5 \times 15 = 7.5$ volts. If 7.5 volts is used up in the armature to cause the current to flow through the winding, then only $Ea = 150 - 7.5 = 142.5$ volts is available at the brushes. The current that $Ea$ will cause to flow through the external circuit the resistance of which is $R' = 4.75$ ohms, is $I = \frac{E_a}{R'} = \frac{142.5}{4.75} = 30$ amperes, which checks up with the values obtained in the foregoing.

The value of one of two resistances connected in parallel is 6 ohms; the joint resistance of the two is 3.75 ohms and the resistance of the voltmeter is 10,956 ohms.

In Fig. 10 if the resistance of each lamp is 220 ohms and the resistance of the voltmeter is 10,956 ohms, what will the reading of the voltmeter be? Also will the lamps light, and if not, why not?

# Coal Conservation Without Shutdown of Isolated Plants

THE continuation of the hearing before the Public Service Commission for the First District of New York on Mar. 18 was rendered unusually interesting by the testimony of C. T. Coley, who appeared for the New York Building Managers' Association. Mr. Coley, who is operating manager of the Equitable Building, proposed a plan whereby the isolated plant for combined lighting and heating could be operated in conjunction with the public-utility plant with a maximum of benefit to the community. The plan involved three suggestions, the common object of which was to save coal without detracting from the value of the various kinds of service.

According to Mr. Coley's argument, the seasons of the year may be divided into three groups, the first group being the winter months of December, January and February, the second group being the six months comprising spring and fall, and the third group being the summer months of June, July and August. A few buildings containing isolated plants produce insufficient exhaust steam from the manufacture of power or electric energy to heat themselves during the three winter months, and it is necessary to draw further on the coal pile by generating live steam, which is turned into the heating system so as to maintain the desired temperature. This is especially true of mornings, nights, Sundays and holidays. The remedy for this condition is to increase the electric production to a point at which enough exhaust steam will be produced to meet the heating requirements and to find a suitable outlet for the excess current generated.

Obviously, the extra energy produced must be used in such places as to save coal or to remove the necessity of burning coal. Two methods of accomplishing this result are suggested. First, to obtain permission to supply other buildings in the neighborhood—across the street, if necessary—with electricity, thus reducing their demands for energy on the Edison company's mains at such times; and second, to run separate units on independent busbars in the isolated plant and synchronize with the 240-volt direct-current mains, pumping electrical energy from the isolated plant out on the Edison company's mains and using the additional exhaust steam thus produced to make up the deficit for heating in the coldest weather.

To illustrate the amount of coal needed for live-steam generation for heating, in addition to the exhaust steam used, Mr. Coley submitted the following statistics of coal consumption in the case of the Equitable Building:

| Month | Coal, in Lb. | Kw.-Hr. | Coal per Kw.-Hr. | |
|---|---|---|---|---|
| June, 1917 | 2,940,490 | 456,896 | | 6.43 |
| July | 2,982,080 | 496,034 | | 6.01 |
| August | 2,928,690 | 461,329 | 6.49 Aver. | 6.34 |
| September | 2,913,120 | 416,866 | | 6.98 |
| October | 3,201,030 | 475,962 | | 6.72 |
| November | 3,205,150 | 411,562 | | 7.78 |
| December | 3,826,190 | 405,129 | | 9.44 |
| January, 1918 | 3,255,700 | 358,678 | 9.09 Aver. | 9.07 |
| February | 2,634,500 | 300,401 | | 8.76 |

The second column shows the total coal used per month; the third column shows the electrical output; and the last column shows the pounds of coal used per kilowatt-hour for all services. During the first five months shown, the average coal used per kilowatt-hour was 6.49 lb., which was about the normal summer rate. During the three winter months an average of 9.09 lb. of coal was used per kilowatt-hour for all purposes. The increase, 2.60 lb. per kilowatt-hour, is due to heating requirements.

The electrical output during the three winter months was 1,064,208 kw.-hr. Then, $(1{,}064{,}208 \times 2.6) \div 2000 = 1383$ tons of coal, which was burned in excess of that required to produce the electrical energy so as to furnish live steam to help out in heating the building.

If this 1383 tons of coal had been used to generate electrical energy, and the exhaust had then been used for heating, it would have been possible to supply to the Edison company's 240-volt mains 553,200 kw.-hr. during the three winter months, assuming 5 lb. of coal per kilowatt-hour. Thus, the coal saved to the community as a whole would be the amount required at the Edison plant to produce that 553,200 kw.-hr. As a central station can produce a kilowatt-hour on 2 lb. of coal, or two-fifths of the quantity used in the isolated-plant calculation, the net saving of coal would amount to two-fifths of 1383 tons, or 553 tons.

The second suggestion for coal saving made by Mr. Coley was that during the months of March, April, May, September, October and November the isolated plant should be allowed to supply electric energy, and particularly exhaust steam, to its neighbors, whether over the street or under it. During these months some exhaust steam is used for heating, but at the same time great quantities are wasted into the atmosphere, while buildings close by are buying steam for heating or are producing it in their own heating boilers, merely be-

cause of lack of permission to run mains under or over streets. Much coal could be saved to a community if it were permissible to supply exhaust steam from engines to buildings across street and such permission should be granted as a war-emergency measure, if not permanently.

The third suggestion was that the Edison company should make a low-rate schedule to apply during the summer months of June, July and August, and maybe include May and September also, to enable isolated plants to shut down for this period and thereby save an amount of coal equal to the difference between what they would burn and what the Edison company would burn to furnish the electrical energy they needed.

### Holding Plant Labor in Nonheating Season

It was pointed out by Mr. Coley that although isolated plants could be shut down during the nonheating period, it would not be feasible to discharge the operating forces; for if that were done, the men thus thrown out of positions would turn to other forms of labor, and there would be great difficulty, if not an actual impossibility, of getting trained men to put the plants into operation again at the beginning of the heating period. The men would have to be retained throughout the summer, and their services could be utilized in making overhauls and repairs to the plant equipment. On this account, any rate for that period made by the Edison company would have to be considered from the coal pile in order to be economic and would have to take into consideration the retaining of the plant operatives.

The impossibility of saving coal by substituting central-station current for that generated in an isolated plant having use for exhaust steam was further emphasized by the testimony of H. Goldstein, who operates two manufacturing buildings in which steam is required from 9:30 a.m. to 6 p.m. The steam is used for power, lighting, heating and various manufacturing processes. According to this witness, the cost of operating one of the buildings by purchasing Edison company current and generating live steam in his own plant amounted to $1000 a month. Later, he installed an engine and generator of sufficient capacity to furnish electric current to the tenants of both buildings, and discontinued the use of Edison company service, with the result that at present he is supplying current and steam to both buildings at a monthly expense of only $700.

Robert E. Dowling presented the cases of the Adams Express Co. building at 61 Broadway and the City Investment Building, in each of which is an isolated plant for furnishing light and heat. Neither building has any electrical connection with the Edison company. The average coal consumption in each building is in the neighborhood of 35 or 36 tons per day, the exhaust steam from the engines being ample to furnish heat for the buildings. If current were obtained from the street service during the warm weather, much of this coal would be saved; but during the seven months in which heating is required, the cost of running the plants to furnish heat would be equal to the present cost for combined current and heating, since all the exhaust is available for heating purposes.

Arthur F. Rice, representing the Coal Merchants' Association, deprecated the shutting down of isolated plants during the warm months, on the grounds that the coal man must have something to do in the summer if he is to maintain his facilities for winter deliveries. He insisted that no coal dealer could afford to keep his men, horses and trucks on the basis of a winter business only.

The hearing will be resumed on Apr. 8.

## Unit Costs of the Cleveland Electric Illuminating Company

The table shows the unit costs of the Cleveland Electric Illuminating Co., as shown by Ballard Exhibit No. 6 in the Cleveland Electric Rate Case before the public utilities commission of the State of Ohio on Feb. 20, 1918.

These values are classified figures taken from Nau Audit, Commission's Exhibit No. 2, and reduced to cents per kilowatt-hour sold by F. W. Ballard & Co. These figures will be of general interest to engineers and city officials.

It should be noted that the unit cost for practically every classification of expense has decreased during this four-year period, notwithstanding the fact that the cost of labor and material has increased owing to war conditions. The kilowatt-hours sold during the four years was: 1913, 123,767,142; 1914, 167,226,182; 1915, 180,800,669; and in 1916, 248,465,487.

EXPENSES AND DEDUCTIONS FROM INCOME FOR YEARS ENDING JUNE 30, 1913, 1914, 1915, 1916
CLEVELAND ELECTRIC ILLUMINATING CO.

| Item | Year 1913 Amount | Year 1913 Cents per Kw.-Hr. | Year 1914 Amount | Year 1914 Cents per Kw.-Hr. | Year 1915 Amount | Year 1915 Cents per Kw.-Hr. | Year 1916 Amount | Year 1916 Cents per Kw.-Hr. |
|---|---|---|---|---|---|---|---|---|
| Total power production | 579,036.20 | 0.4680 | 654,261.86 | 0.3908 | 605,513.83 | 0.3350 | 796,136.46 | 0.3208 |
| Total transmission | 36,888.00 | .0298 | 50,964.03 | .0305 | 62,977.85 | 0348 | 64,059.19 | 0258 |
| Total storage | 2,435.81 | .0019 | 3,522.00 | .0021 | 3,237.29 | 0018 | 5,485.60 | 0022 |
| Total distribution | 145,065.55 | .1173 | 195,657.26 | .1170 | 209,567.21 | 1159 | 219,034.88 | 0882 |
| Total utilization | 85,833.13 | .0694 | 93,791.60 | .0561 | 92,282.69 | 0511 | 82,573.78 | 0332 |
| Undistributed | 2,027.31* | .0016* | 2,544.17 | .0015 | 3,751.27* | .0021* | 11,359.82* | .0046* |
| Administrative | 185,948.38 | .1520 | 202,351.96 | .1210 | 211,726.94 | 1170 | 256,411.79 | 1032 |
| Commercial | 104,796.51 | .0846 | 124,842.01 | .0745 | 129,156.66 | 0715 | 143,644.78 | .0577 |
| Business promotion | 105,045.80 | .0850 | 140,414.13 | .0839 | 156,348.14 | 0865 | 177,284.61 | 0713 |
| Injuries and damages | 27,906.28 | .0225 | 43,398.00 | .0259 | 36,340.00 | 0201 | 15,487.00 | 0062 |
| Public regulation expenses and undistributed | 15,480.26 | 0125 | 7,348.59 | 0044 | 7,944.06 | 0044 | 8,395.79 | 0034 |
| Deferred upkeep | 403,029.11 | .3260 | 513,461.75 | .3070 | 445,215.38 | .2465 | 566,962.94 | .2280 |
| Interest on funded debt | 294,409.51 | .2380 | 300,625.00 | .1793 | 318,456.96 | 1760 | 339,667.70 | .1365 |
| Other interest | 26,852.23 | .0217 | 28,901.13 | 0173 | 12,471.16 | 0069 | 2,277.89 | 0009 |
| Taxes | 246,151.92 | 1991 | 301,872.07 | 1802 | 324,989.24 | 1798 | 341,180.77 | .1372 |
| Amortization of discount | 60,539.70 | 0490 | 12,876.00 | .0077 | 13,355.15 | 0074 | 13,378.72 | .0054 |
| Employees fund | 37,124.33 | .0300 | 82,559.70 | .0494 | 63,860.71 | 0352 | 63,823.89 | .0257 |
| Valuation and regulation reserve | ..... | ..... | 46,250.00 | .0276 | 23,125.00 | .0128 | 57,323.20 | .0230 |
| Total | $2,354,515.41 | 1.906 | $2,805,641.26 | 1.675 | $2,712,816.99 | 1.500 | $3,141,769.17 | 01.264 |
| Total, excluding deferred upkeep, and interest on funded debt | 1,657,076.79 | 1.339 | 1,991,554.51† | 1.192 | 1,949,144.66† | 1.078 | 2,235,138.53† | 0.900 |

* These figures are deficits. † These amounts shown on Complainant's Exhibit No. 25, Page 1.

# Secretary Lane Supports the Water Power Bill

## He Points Out That Water Power Will Not Be Developed Under Revocable Permits, but That Long-Term Leases with Fair Recapture Provisions Furnish a Workable Plan

SECRETARY LANE of the Interior Department appeared at the hearing on the Administration water-power bill before the Joint Special Water Power Committee of the House of Representatives in Washington Wednesday, Mar. 27. After pointing out that the bill now before the committee has a long history and reciting some of the attempts to bring about water-power legislation during the last five years in which he and others have been concerned, Secretary Lane said that the matter of developing one bill in Congress was taken up, and that there was strong opposition in some quarters against any kind of leasing system. "Perhaps a very considerable portion of the time I have devoted to this matter," he said, "has been spent in attempting to convert members of the House and Senate, who had notions in opposition, that the leasing system was the only practicable one."

### Revocable Permits Unsatisfactory

The Secretary pointed out that there is still on the books a statute under which revocable permits are granted, but that the men who have money to invest in water-power propositions are not willing to allow any official to say when the investment they have made shall be thrown to the winds. The result, he said, has been that "we have stood for five years of which I know almost entirely without development of one of our great resources. Now, it is not merely the West that is concerned in this; it is the East just as well. Right now I can call your attention to one particular matter that shows how intimately East and West are tied up on such a proposition. You know John D. Ryan, of the Montana Power Co. He has private rights, or his company owns certain dam sites and rights along rivers in Montana. I sent out a general request some time ago that the Eastern minerals which had not been heretofore developed in very great quantities, such as manganese and chrome, should now be developed for the purpose of saving ships. We get manganese, as you know, from Brazil. It takes a very large tonnage. We import some 800,000 tons a year. We get chrome from Africa and New Caledonia. We get nitrates from Chile, and for all those things a very large number of ships are at present required. We are short, the Allies are short, for the carrying of nitrates to the other side and to this side, . . . short for carrying pyrites from Spain to this side, . . . short for carrying manganese from Brazil, . . . short for carrying food to our own boys on the other side, and munitions and food for the Allies; and no matter what comes out of this German drive now going on over there, there is an obligation upon us, and the pressure of necessity that we should supply those people on the other side.

"For that we must have ships. Now, Mr. Ryan came to me and said he had a plant in Montana which will develop 150,000 hp. That horsepower can be used in a process by which the low-grade manganese ores we take out of the Butte mines can be reduced, and by their reduction they can be made commercially available to the plant in Pittsburgh. So that a water power 2000 miles away in Montana makes possible the development and the support of industries in Pittsburgh and relieves ships that come all the way from South Africa."

Secretary Lane then again went into the history of the various bills that have been before Congress and said that the executive branches of the Government, in the present bill, had united upon a measure under which "leases could be made that would govern the navigable waters and the unnavigable waters, and control as to public lands and as to forests." He told the committee he felt sure its members would find the House and the Senate in support of a measure, such as that under consideration, which does the following:

"Gives a lease for a definite term of years not to exceed fifty years; gives an opportunity for the Government to take over the property at the end of that period; gives an opportunity if the Government does not want to take over the property at the end of that time for the lessee to take it over, and I should say that reasonable terms to him would be that he should have that property if the Government does not wish to use it and that he should have that property upon terms that would be no more favorable to him than those that others might offer, but that he should have a preference. . . . Into the hands of the men capable of developing them should be given sufficient to make a wise and large investment and development; we cannot save things for men who have no capital or men who go about things with a spade where a steam shovel is needed."

### Right of the People Is Paramount

The Secretary spoke of the right of the community, of the nation, pointing out that the right of the people of the United States is superior to any right "that you or I might have to speculate upon those things that are primary resources," and adding that he believes as to lands and as to minerals and as to water powers that no man is entitled to anything unless he uses it.

"If we had money enough," he continued, "if this were not a time of war, if we could think in the terms of money that we are now thinking of, or if four or five years ago Congress had been willing to expend hundreds of millions of dollars in the development of water power as it is forced now to spend millions of dollars for war, it would be a wise thing to put a large part of the public revenues into such projects where they are found to be needed.

"I have no doubt in my own mind but that such schemes as water-power schemes are perfectly practicable from a Governmental standpoint, no matter what your sympathies may be respecting Government ownership, as a rule, of large utilities. A thing that is as well standardized as a water-power scheme can be

operated successfully by the Government. But I do not take it that this is a practicable proposition at this time, nor probably will it be for many years to come, and it is necessary that there should be real development, and that soon." Mr. Lane elaborated his point of view in regard to the impracticability of devoting Government funds at this time to the building of water-power plants by discussing the immense demands being made upon the Treasury now and in prospect.

"The news now coming from the other side of the water," he said, "is disheartening, discouraging, but it leads me to believe that all the conclusion we can come to is that we are in this thing for a longer time than we thought. Not that there is to be any cessation of effort on our part, but there is to be renewed effort, a stronger fight, and a longer fight. And if we are to have a long fight, and if we are to get into this thing with our full strength; if a larger portion of the burden of beating von Hindenburg and the other Germans is to fall upon us, then, surely, it becomes necessary that we should not delay longer in the development of every resource that we can."

Secretary Lane spoke at this point again of the nitrate situation, pointing out that it is not one that can be looked upon with equanimity and remarking that "the more nitrates we have the more food we can get," as well as "There is a large portion of the acreage of this country that is now coming to need fertilizers of one kind or another."

The speaker then told of an offer he had had from a company in Washington five years ago for the development of a water-power proposition. "That proposition," he said, "could have been financed successfully at that time if we had had such a bill as the one which is now before you. Then they wished to go into the business of developing nitrates. The power is still there and is still unused." He said that there are propositions of this kind all over the country, that there is a supreme obligation upon all the people of the country at this time, as well as its officials, to think more seriously of such things, and that "we will get no development under the present law."

### Not in Sympathy With Government Loans to Private Enterprises

Answering questions by Chairman Sims, Secretary Lane, before entering upon a general discussion of his remarks, participated in by almost all members of the committee, said that if there is a determination by Congress that there shall be water-power development—for instance, along the Columbia River, or the Snake River, or the Colorado River, for the production of low-grade manganese, or for the development of nitrates, either for gunpowder or for fertilizer—and such works could not be financed, "it is the duty of the Federal Government at this time to help out the proposition and put it on its feet." He added: "I am not sympathetic generally with the idea of having the Government lend money to private enterprises because it is a hard thing to get it back. But I am very much in sympathy with the Government doing what it pleases with its own money, provided it knows where it is going and what it wants and how that money can be properly handled; and I am not afraid at all of the Government undertaking the development of water-power propositions, because we have had some experience with them in the Reclamation Service. The Salt River proposition which I have turned over to the water users is practically paying its own way now out of the power developed out of the Roosevelt dam. That was a venture at the time. All these propositions are gambles. That is one reason why a man who puts his money into a water-power project has got to have very real consideration. He is a developer, and every man who is a pioneer of any kind takes the risk, and for his risk he ought to be compensated."

Mr. Lane was asked some questions as to whether it will be possible for water-power plants to be built in time to be of service before the war is over. Very close attention was paid to the answer of the Cabinet officer on this point because men in public life in Washington have not recently been hazarding guesses as to the length of time which the struggle will continue. He said: "I have no expectation that this war will be over before water-power projects such as many that we know of can be developed. I think you have got to look at that thing with a long range."

## Why I Buy Liberty Bonds

By George W. Munro
Assistant Professor Mechanical Engineering, Purdue University

Last spring twenty students of my class responded to the call of the nation and joined the colors, and this response was prompt, spirited and enthusiastic. Some of these boys are already on the fighting front and a few weeks will see them all at the grim business. These twenty men who have left my classroom for a place on the very lips of the bloody jaws of hell represent me in a very personal way, and I expect great things of them. I expect them to be brave with a courage which knows no faltering; I expect them to be chivalrous before an enemy wholly savage; and I expect them to reflect honor on my nation, my state and my university in all their dealings with men and women, friend and foe alike.

Of me they have a right to expect in return that I will not send them into a strange land to die of want and neglect. From me to them must flow a never-ending stream of food, of shelter, of clothes, of arms and munitions, of hospital supplies, of encouragement and good cheer. I must provide ships for their passage and provisioning, convoy for their safe conduct, aircraft for their battle eyes; and all the things which are necessary for their well-being, without limit or stinting. It is evident that I cannot serve these men directly but must use the agencies provided. I must support the Y. M. C. A., the Salvation Army, the Red Cross. I must pay cheerfully and gladly such war taxes as come within my reach and must buy Liberty Bonds and War Saving Stamps to the limit. Only so can I meet the reasonable expectations of those who have gone forth from my classroom to the edge of the abyss.

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We are loud in our praise of James Watt for what he accomplished, but it is doubtful whether Watt would be as proud of his successors who are throwing away steam in the form of exhaust that is as good as some he used initially.

# Why we should Buy Liberty Bonds

One year ago President Wilson said: "We will not choose the path of submission." Buy Liberty Bonds and show that you agree with him.

Germany has announced her eighth tyranny loan. We have offered our Third Liberty Loan. Can we allow ourselves to be outdone by Germany?

"When innocent blood from the four corners of the world cries out for justice," what will your answer be? Speak through the Third Liberty Loan.

Time enough to beat the sword into plowshares after the Kaiser is beaten into submission. The Third Liberty Loan is an effective weapon against him.

That man in khaki, to whom you wished "best luck," wants you to buy Liberty Bonds and show that you meant what you said.

If you don't believe in the premature peace that the pacifists demand, if you don't want to see the United States "Russianized," buy Liberty Bonds.

The time to talk peace is when the Germans lay down their arms. Just now, let your money talk in terms of Liberty Bonds.

Our Allies keep on supporting their war loans; Americans cannot afford to hang back in this Third Liberty Loan, when most of the civilized world is united against Germany.

You buy Liberty Bonds because you believe with every American in backing this war to the last dollar, the last soldier, the last ounce of energy.

Uncle Sam is offering you one kind of bonds, and the Kaiser another. The Kaiser's don't fit Americans of the breed of Washington, Lincoln and Wilson.

You owe a debt of freedom to America. Buy a Liberty Bond and help pay your debt.

Buy Liberty Bonds because they help to arm, outfit and feed the soldiers and sailors who are fighting democracy's battle under your flag.

Buy Liberty Bonds because they give you a chance to enter the richest partnership in the world, the United States of America.

Buy Liberty Bonds because the man behind the gun is doing his all and you want to do yours. He cannot fight long without your help.

The campaign for the Third LibertyLoan is a spring drive in which every American is summoned over the top. And let us all be shock troops.

Translate your good intentions intoLiberty Bonds. Russia today is paved with good intentions—for the Germansto walk upon.

Our boys in France are as anxious as the Germans to know whether the Third Liberty Loan has been oversubscribed. Which will you disappoint?

You must buy a Liberty Bond to preserve your self-respect, to still your conscience and to prove your patriotism.

Purchasing a Liberty Bond will mean helping insure these United States against depredatory powers for ages to come.

Each of us should buy Liberty Bonds to assume at least part of the individual responsibility which the war imposes on the nation as a whole.

Unless we lend to the Government voluntarily by investing in Liberty Bonds, the Government will be forced to conscript our wealth.

Because those who have enlisted set an example of sacrifice, knowing that Liberty would be won by the small sacrifice made by those who remained behind.

Because by buying Liberty Bonds you are helping yourself and your country.

*The American Citizen Should Buy Liberty Bonds Because they are for the Purpose of Defending His Country and His Home*

# Editorials

## Daylight Saving the Year Around

THE Calder Daylight Saving Bill that provides for changing the working hours throughout the United States has been signed by the President and is now in force and will so continue until October 27 of this year, when the clocks will be set as they were before the change. It would seem that the idea might be carried still farther and the law so amended as to become effective throughout the year.

There are several features favorable to this change of working hours which would affect the home, the factory, the office and also electric-light plants. During the summer the saving in the home would center around the evening illumination, an hour's less lighting being required each day. During the winter months lights would be used both morning and evening, but the extra hour's lighting during the morning would be more than offset by the greater number of lights that would be shut off an hour earlier at night.

In the office buildings, in the larger cities at least, opening for business one hour earlier in the morning would not require the burning of lights and would save an hour's lighting in the late afternoon during the winter months. The lighting period in the factory would be shortened to some extent, depending upon the natural light conditions. During the period when the days are the shortest, the morning and evening lighting load would about balance, but during the early and late winter months the change of working hours would result in a saving of light.

These savings of light would result in a cash gain to the user, but to the electric-light companies it would mean a loss in revenue. On the other hand, such a loss would be beneficial in that the power load for the day and the evening lighting load would not overlap. Furthermore, it would not be necessary to maintain expensive equipment to carry the peak loads, as it is now. With a more even load on the stations, the boilers that are now held in reserve with banked fires in order to carry the peak loads caused by the lapping of the power and lighting demand would not be required.

Just what such a daylight-saving plan would amount to in coal saved by the power plant and to the consumer of electricity is shown by the statement of Samuel Insull, chairman of the Illinois State Council of Defense and president of the Commonwealth Edison Company of Chicago, which is to the effect that the enactment of an all year's daylight-saving law would save the electric industries of Chicago alone about fifteen thousand tons of coal per year and about two hundred and thirty thousand tons of coal for the entire country; and then it would save the electricity consumers in Chicago about three hundred and sixty-five thousand dollars and for the country seven million and a half dollars per year, which, by the way, would be the loss to the electric companies in revenue. This loss, however, would be largely offset by an improved load factor because of the reduction of winter peaks, and in many instances it would mean real economy in operation as well as a saving to the country as a whole.

## Invest To Destroy Autocracy

THERE are two kinds of power. The first is the kind that is developed from the latent heat of coal or the self-perpetuating source of energy of waterfalls. The second is what is being temporarily exerted by Germany today—man power gone mad.

The former is the mainstay of all industry; the climax of man's intelligence. Through it vast distances have been opened for transportation, vast enterprises carried out to a successful end. Indeed, it is safe to say that the wheels of all industry would never have rolled in the wealth they do today if energy had not turned them into proper channels. With the wheels of industry yet unborn, the whole fabric of our every-day existence would be still an impossible dream. Your work, then, is the work of progress, development and the conquest of man over the uncurbed forces of nature.

The second phase of power has no part in the progress of civilization. Its presence is intolerable. By the power gained through ruthless savagery, Germany has conquered a large part of the unfortunates who have been unable to escape. Her power is the mad frenzy of a beast drunk with the blood of her helpless victims. It is well that that kind of power lost its place among mankind when civilization first made itself felt.

Those of us who are not in the army can stand together in helping to put down this uncontrolled and autocratic power, by subscribing to the Third Liberty Loan. Save for it; every cent you invest in Liberty Bonds goes toward helping to destroy the power of the beast of Europe, that power which is striving to destroy all that every true American holds dear.

## Government Control of Water Powers

THE article "Government Control of Water Powers and Electrical Distribution Abroad," in this issue, deals with a question that demands the close attention of those interested in central-station work and the development of the water powers in this country. The policies of governments in their attempts to deal with the production and distribution of electrical power have undergone frequent changes following the rapid development of the central-station industry. The progress made in the development of overland transmission and the great saving to be derived from centralized production have opened the way for a new development in power legislation which seems to lead in the direction of complete governmental control over all agencies of power production if not finally to national ownership.

It is interesting to see how the attainment of this

end is approached in the different countries. In England the power engineers and those interested in power consumption have worked out an extensive scheme which will centralize power production in a comparatively few generating stations which will supply a territory now served by more than six hundred central stations. Prussia forces its central stations to fall in with its own policies by simply taking administrative action which will make it impossible for the existing enterprises to expand unless they do the will of the government; it has also entered the central-station business on its own account and now competes against the existing private and municipal enterprises, assisted by large generating stations conveniently situated. Finally, there is the example of New Zealand, where government ownership has been in successful operation for many years.

The importance of reserving the existing water-power resources of the country so that they may be used to the best interest of the nation is now generally realized throughout the world, and many laws have been passed regulating the use of waterfalls and other natural power sources. With increasing industrial activity it has become essential that this power should not be squandered and that it should be provided for all at the cheapest possible rate. This can be done by a better use of the existing natural resources and by centralization of the existing central stations. While the means to that end used in the different countries differ, it seems that the final outcome in each case will be identical.

So far there is no evidence that it is also contemplated to nationalize the means of distribution. On the contrary, opinion seems to be very largely in favor of continuing the existing organization, which has proved itself to be the most practicable for the purpose.

The development is one which certainly cannot be lost sight of in our own power industry. With the whole world striving today for a cheapening of power production, it is certain that similar action will have to be taken very soon in our own country.

## Bonus for Boiler-Room Crews

THE world was never so aroused to the need of saving fuel, indeed never was so astounded by its wasteful use, as it is now. *Power* has watched with keen interest the effect of the great volume of publicity directed chiefly to firemen and engineers, pleading with them to save coal. The good this publicity has done is not the measure of fuel actually and immediately saved. This is yet to come. The great good comes through the channel in which, unwittingly, the manufacturer and manager have stood as obstructions. Of course there are many exceptions. But many of these men did not realize before the coal shortage how vital a factor is coal and how important it is to check its use in the power plant. Thousands of such men, who heretofore would not listen, or would listen unconvinced, to pleas of their engineers for instruments to gage power-plant performance or for equipment to better such performance, will give a willing ear from now on.

Begging firemen and engineers to save coal, appealing to their patriotism to do this, will do some measure of good. But to him who knows, there are limitations soon reached by such a course. In last week's issue, Haylett O'Neill, well known to *Power* readers, proposes a plan by which boiler-plant crews may receive bonuses for fuel saving effected by careful attention to operation and maintenance of boiler-room equipment. Here is something that gets the enthusiastic support of the crew just as soon as they understand what it is all about.

The author proposes paying a bonus only to the firemen, fire cleaners and boiler cleaners—that is, to those whose work it is to burn the coal economically and keep the boiler and furnace in the "pink" of condition physically. Assumably he includes the foremen when applied to large plants, and the engineer also in plants where he is responsible to the management for the condition and performance of the boiler plant.

## The Daily Grind

THOUSANDS of men in thousands of power stations in the United States and, in fact, throughout the world are obliged to go through with the daily grind. One day is very much like the next, and it frequently gets to be an old story for some. The duties of the engineer and fireman are not always pleasant. There is a continual handling of coal, feeding of water, disposal of ashes, blowing down, cleaning, oiling, wiping, repairing, making of reports—all necessary and responsible work, but ofttimes dull and irksome. The boiler or engine room is no place for the mollycoddle. There are dirt, soot, scale, heat, poor ventilation, inadequate equipment—all enemies of the self-respecting operator. One is really tempted at times to ask himself the fruitless question, "What's the use?"

But there is another side to all this. If the work of any man in a power plant is uninteresting, it is his own fault. The very fact that there are enemies to conquer makes life interesting. Even the simplest duty is worthy of the best efforts and calls for the exertion of the greatest powers of the whole man. Many people, whatever their occupation, only live half a life. They fail to recognize their opportunities. They spend their energies bemoaning their fate or cursing their luck or wishing that they were born rich or good looking. What a waste of time! How much better would it be if they took an equal amount of pains to improve conditions. Nothing is so bad but that it can be made better, and the way to make it better is to think, talk, decide and do.

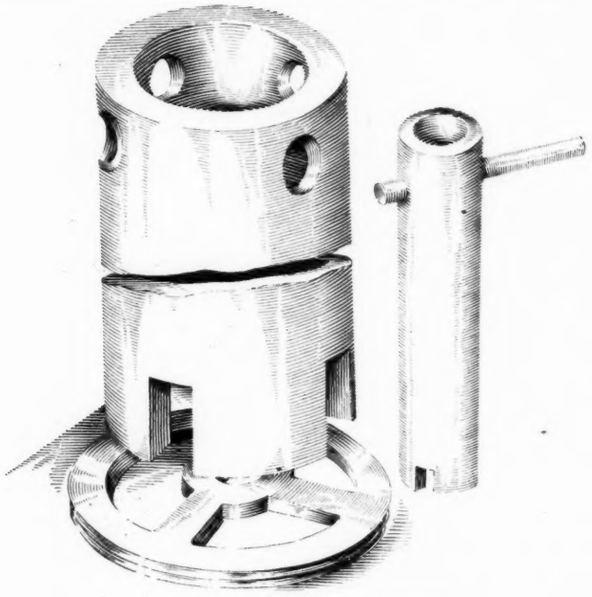
Cheerfulness is the best servant of any man. Some men about a plant are so disagreeable that they are actually shunned by their fellows. They are not only burdensome to themselves, but they are a pest. Whatever good they may wish to accomplish is already nullified by their very attitude.

We are said to be creatures of our environment, and to some extent this is doubtless true. Fortunately, however, it lies within our power to alter our environment. If you don't like your job, get out and secure one that you do like, but make sure first that it is the job, and not you, that is disagreeable. If the daily grind seems irksome, do your best to make it interesting. Do not be discouraged by setbacks. The best fighter is the man who cannot recognize failure—who does not know when he is licked.

# Correspondence

## Pump-Valve-Seat Wrench

A valve-seat wrench made of pipe with slots cut in the end to match the spider of the seat will prove effective and will serve in awkward places, such as depressed decks or where there are projecting studs.



PUMP-VALVE-SEAT WRENCH

It may be turned with a Stillson wrench or with a bar in holes drilled in the pipe.

I have taken seats out without injuring them where it took two men with a 6-ft. pipe on a 48-in. wrench to start them—the wrench being made as described of 3-in. extra-heavy pipe. The pipe should be the largest size that can be put into the valve to bring the force as near the point of resistance as possible.

San Francisco, Calif. ARTHUR B. SAUNDERS.

## Gas Engines of Former Times

Referring to the letter, "Gas Engines of Former Times," on page 164 in the issue of Jan. 29, it may be interesting to *Power* readers to know more about a gas engine called the Automatic, which was manufactured at Oil City, Penn., about the date referred to. This engine had the following earmarks: The ones that I came in contact with were horizontal four-stroke-cycle with one rotary valve driven by a camshaft. This valve controlled the air inlet and also an exhaust. Ignition was obtained by the old-time hot tube, and the governor was of the throttling type, controlling the quantity of admission. The engine was nicely balanced, was almost noiseless and would run at a high rate of speed. Trouble, however, always developed in the rotary valve, cutting and causing loss of compression.

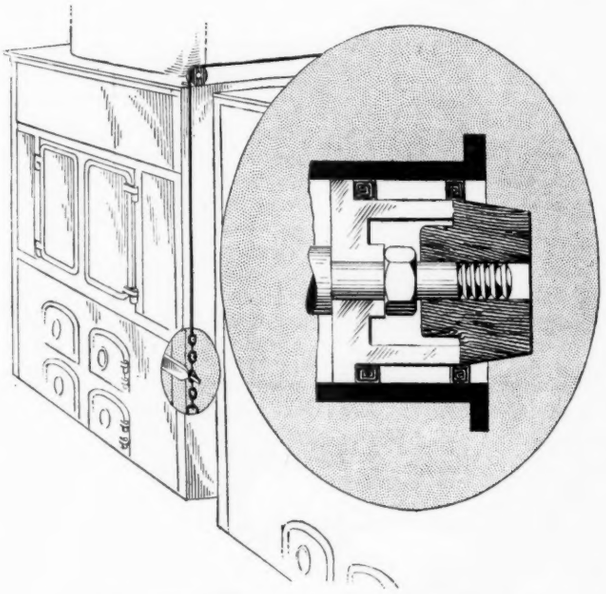
This made a bad job to repair, and I think that was what put the engine off the market. I have heard that some shops fitted poppet valves to these engines and got good service from them. It occurred to me that the writer of the letter referred to may have had one of these engines or that some other contributor might be able to give some interesting reminiscences in regard to it. LLOYD R. HOFFMAN.

Oil City, Penn.

## Holding Damper in Position

A damper control can be put in in a cramped place if ¼-in. wire sash cord is used with "side pulleys" at necessary turns, and it will last indefinitely. I use a section of light chain down the boiler front, of a length equal to the travel of the damper lever, securing it over a hook at any desired damper opening—the chain serving also as an indicator of the damper position.

For the relief of distressed worthy brothers whose patience and stock of profanity runs out when they try to pack the water end of a feed pump, especially



TWO SELF-EXPLANATORY SUGGESTIONS

when it is hot and valves leak, I would recommend the kind of device I use, for I can drive the packing into place as fast as a helper can cut it. It is a tapered wooden plug, the large end of which is the same size as the body of the piston, with a hole in its center of the same size as the projecting end of the plunger rod or the locknuts and deep enough for the plug to butt against the piston. The packing rings can be easily slipped over the small end and driven into place by this means. ARTHUR B. SAUNDERS.

San Francisco, Calif.

## Favors an Ash Inspector

The editorial on page 267 in the issue of Feb. 29, regarding appointing ash inspectors strikes me as being mighty good dope. Last winter at my home we burned eight tons of pea coal, not sifting any of the ashes. This winter, sifting them, we have not burned six tons yet, and we expect to use not more than six and one-half tons. If a ton and a half out of eight can be saved by sifting the ashes as we have done this season, I can easily imagine what a big saving can be made in the nation's coal pile by having an ash inspector or someone to take care of the ashes not sifted.

One large city in the East has considered the proposition of building an ash-sifting plant, and it was thought that enough coal could be obtained from the ashes gathered to run the city several months of the year. This estimate, I believe, is not far wrong, for in walking along the streets in the morning I have noticed that the contents of the ash boxes are nearly half coal.

New York City. D. R. HIBBS.

## Protection of Furnace Walls

In the Jan. 8 issue of *Power* appeared an interesting article on "Ventilated Side Walls." In hand-fired furnaces with natural draft it is highly desirable to eliminate abrasion from firing tools and clinkers. As pointed out in the previous article, perforations in side walls are of little effect in furnaces of this type. We have used with success side grates of special design, not only to overcome the clinker troubles, but also to improve combustion conditions when the coal contains a considerable amount of volatile.

Fig. 1 shows the side grate in position. By correctly proportioning the free area and height of these grates, the quantity of air entering over the top of

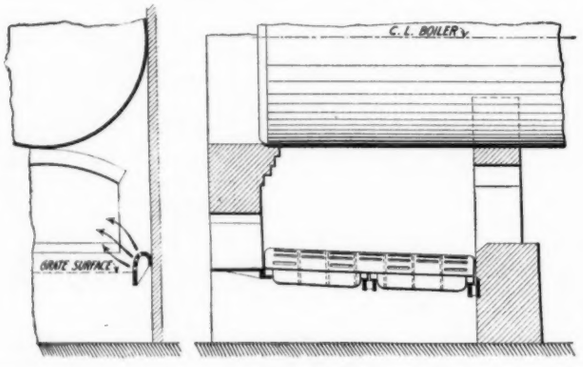



FIG. 1. PERFORATED SIDE GRATE TO ADMIT AIR, OVER FURNACE

the fuel bed is practically self-regulating. After a new charge the fuel bed is thicker and offers greater resistance to the air than after the fuel is partly consumed. The air will seek the path of least resistance and, when the new charge of fuel is introduced, will pass through the openings of the side grates at a greater velocity when it is needed above the fuel bed to consume the volatiles. The greater velocity will also help to effect a better mixture of air and combustible gases. The lower resistance of the fuel bed during the later part of the period decreases the inrush of secondary air through the side grates. This difference seems comparatively small, but has proved its effectiveness in practice. Care must be taken to supply these side grates with proper cooling surface. The proportioning of the cooling ribs and the air openings spell success or failure. In the furnace shown in Fig. 1 there is also provided a flame port formed by an arch over the bridge-wall, as a means of enhancing the mixture of the furnace gases and air. Openings are provided to hinder the formation of gas pockets.

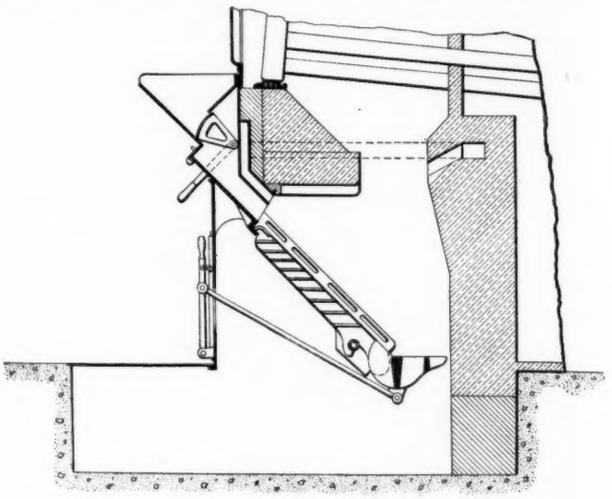


FIG. 2. SIDE GRATE FOR SLOPING FURNACE

Fig. 2 shows a successful side-grate installation for a sloping-grate furnace. In this case the construction of the side grates is more simple. The only delicate point is the provision of sufficient cooling surface to prohibit excessive temperatures and premature destruction of grates.

JOSEPH GODER,
Chicago, Ill. Boiler Efficiency Engineer.

## Using a Pitot Tube

In the issue of Feb. 5, page 195, Mr. Brye gives suggestions concerning the use of a pitot tube. It is not my purpose to discuss the construction of the tube as shown; although one might criticize some features of it, there are other features that are admirable. I wish to call attention only to the difficulties connected with his plan of determining the average velocity in the pipe. In the first place it is somewhat troublesome in practical work to divide the cross-section of the pipe into concentric areas that are equal; then, after having thus divided the cross-section, it is exceedingly hard to locate the tube at exactly the right position in each of these equal concentric areas. In the third place there would be a comparatively large distance near the middle of the pipe in which but one velocity reading would be taken. Under certain conditions it would be very desirable to have more readings from this central area.

I would suggest that it is much easier to take the velocity readings at definite distances (which may be equal or unequal) along the diameter of the pipe. In determining the average velocity it would be necessary to calculate the area in cross-section of the water traveling at any of the obtained velocities, then giving proper weight to each of the calculated velocities, the average velocity is obtained. E. J. FERMIER.

College Station, Tex.

## Operating Induction Motors at Reduced Frequency

A mill operator requested that the motor drives in his plant be investigated for the purpose of reducing the speed of practically all the machinery. It was found that there were about thirty motors in the mill, most of them direct-connected to the machines they were driving and all operated from the mill's electric plant. The trouble, it appeared, had come about by the mill designer's errors in calculating the motor speeds, and the machinery was considerably overspeeded, so much so in fact, that the quality of the product was seriously impaired.

The power plant was found to be operating at the proper frequency and voltage and was in excellent condition. As an experiment the governor on the engine was changed to reduce the frequency 10 per cent., or from 60 to 54 cycles. The mill machinery operated properly at this speed with the exception of one or two belted motors on which the pulleys could be changed easily, so it was determined to continue the operation at the reduced frequency. However, when heavy loads came on, it was found that the voltage dropped seriously although it was controlled by a regulator.

After some testing it was found that the exciter, which was belted to the alternator, was running too slow to generate sufficient voltage to properly excite the alternator's fields. The pulley was changed so as to increase the speed of the exciter slightly above normal, and after this change no further trouble was encountered, and the plant and mill have been operating continuously since.

During the test after the governor had been adjusted, attention was given to the electrical operating characteristics of the equipment, but the instrument changes were slight except on the frequency meter. The kilowatt output was slightly decreased and so was the power factor; the amperage increased slightly, and the voltage remained constant. D. R. SHEARER.

Johnson City, Tenn.

## Different Rate of Scale Formation in Boilers

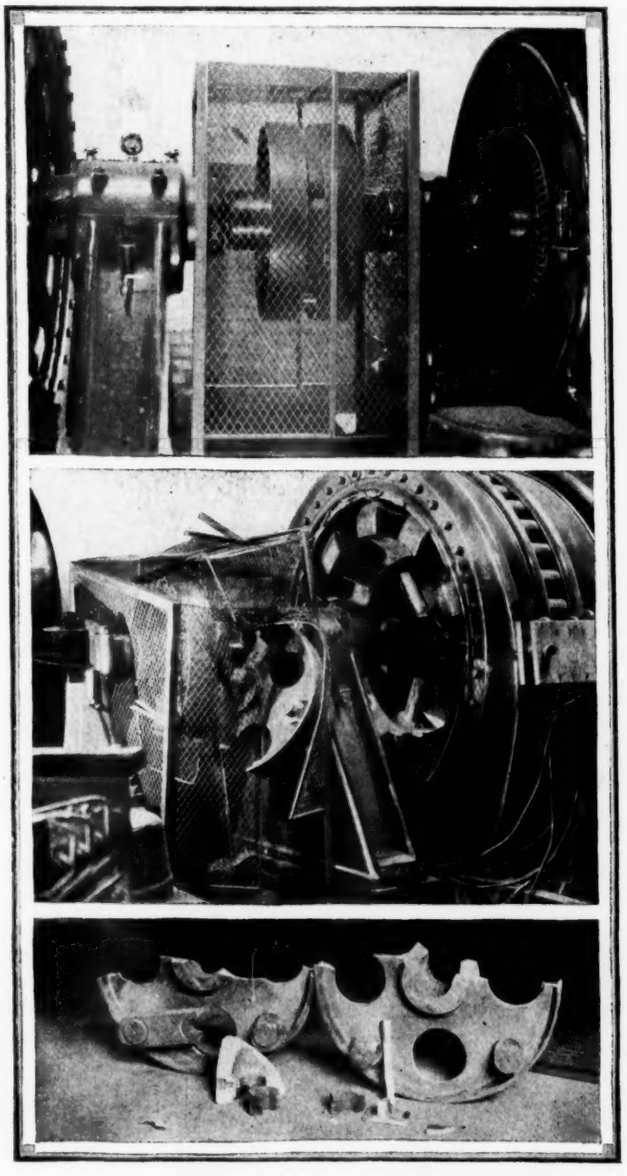
The letter by Mr. Bennett in the issue of Feb. 12, page 231, regarding the different amounts of scale to be found in boilers interested me very much. At one of our boiler plants we have six large B. & W. boilers, all working under the same pressure and using the same feed water, but one-half of each boiler will always have more scale than the other half. The difference is so great that, when cleaning, three or four tubes on the easy side can be bored in the time it takes to bore one on the hard side.

These boilers have been in use for many years, and this condition has always been the same. During the time they have been in operation, the feed water has been taken from three different sources; still the same condition exists. The soot is removed by inserting a blowpipe at one side through openings provided for this purpose, and this is the side that is always found with the greatest amount of hard scale. Whether this is what makes more and harder scale on that side than on the side where no blowing is done, I am unable to say. THOMAS J. PASCOE,

Norway, Mich. Oliver Iron Mining Co.

## Safety Guard Prevents Injury

The upper photograph shows a wire-mesh guard around a 30-in. (diameter) shaft coupling on a motor-generator set operating at 360 r.p.m., the middle one shows the broken coupling with all the pieces retained within the guard or directly underneath on the floor,



CONFIDENCE IN GUARD JUSTIFIED

and the lower one shows the broken coupling after removal. This accident happened in one of the substations in the San Francisco District on Dec. 27, 1917. I am sending these photographs, thinking that they may be of interest to *Power* readers, bringing out the effectiveness of this guard not only as a protection from contact with revolving parts, but also from flying parts in case of breakage. V. R. HUGHES,

San Francisco, Calif. Safety Inspector.

## Telescopic-Oiler Discussion*

The discussion of telescopic oilers recently appearing in *Power* has brought out useful points. As H. Hamkens pointed out at the beginning of the discussion, the main disadvantages of most telescopics, especially the older ones, are too many parts, leakage of oil, tendency to irregular feeding, too rapid wear. He might have added, the almost general difficulty of nonalignment after repairs and cleaning.

It is true that the older telescopics were somewhat complicated and, what with numerous springs, locknuts, washers, etc., they were hard to keep in repair and in good working order. But the design has gradually been simplified and improved until today oilers can be procured which are apparently as simple as it is possible to make them.

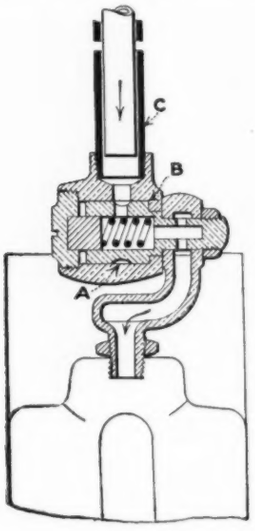



FIG. 1. MR. FENNO'S ARRANGEMENT

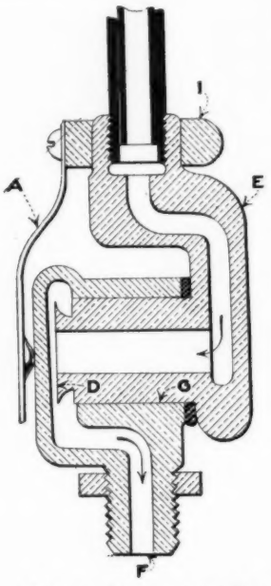



FIG. 2. MR. NUGENT'S DESIGN

As Mr. Fenno pointed out in his article in the July 17, 1917, issue, the tendency to pumping and irregular feeding can be overcome simply by providing suitable clearance between the inner and outer telescopic tubes.

The rapid wear of the tubes noticed by Mr. Hamkens in some instances, is the result of their binding upon each other due to imperfect alignment either when installed or after reassembling. This can be avoided by due care when installing and, with some telescopics, extreme care when reassembling. It all depends upon the type of joint employed.

By employing the special design of true male and female joint shown in the illustration, all wear due to imperfect alignment, except that due to poor installation, is completely avoided, because no threading is even disturbed. Also, because this joint permits of gravity feed, the pumping tendency is practically, and leakage completely, eliminated.

With the arrangement shown by Mr. Fenno and illustrated in Fig. 1, the oil accumulated at the bottom of the outer element as at *A*. In other words, the flow of oil is against the direction of the joint instead of with it. Hence, the fiber packing *B* is always in contact with the oil and subject to deterioration and leakage.

In most of the older designs the joint could not be taken apart without first unscrewing the telescopic pipe *C*. This meant that with any irregular alignment whatsoever in the initial assembling, the pipe would have to be screwed up to exactly its original position when reassembled, or extreme wear was sure to ensue.

With the type of joint shown in Fig. 2, both wear and leakage are practically overcome. The overhanging lip *D* drops the oil from the movable element *E* directly into the hollow of the fixed element *F*, and hence, unless the oil is fed in a flood greater than the latter can conduct it to the pin, the joint *G* remains leakless.

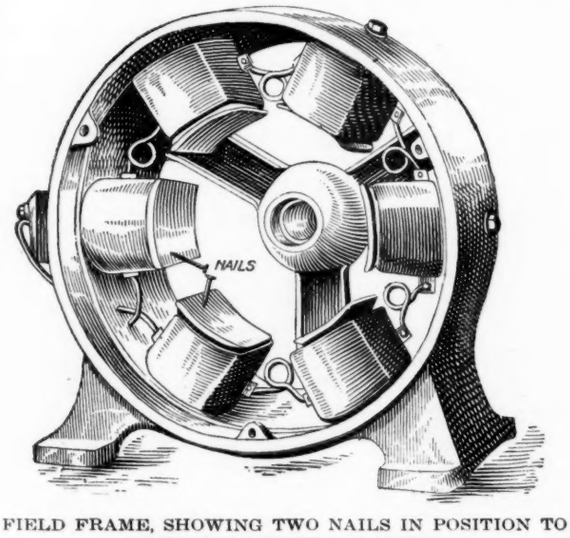
The joint is taken apart by sliding off the spring clip *A*, which is attached to the loose collar *I*. The movable element *E* then slides out of the fixed element *F*. As the construction at the top of the telescopic is similar, the telescoping pipes may both be removed without detaching them from their parts of the joints. Hence, they can always be replaced in alignment. As no nuts or screws are used in putting the joints together, they may be taken apart for cleaning or inspection while the engine is running unless the speed is uncomfortably high.

Chicago, Ill. WILLIAM W. NUGENT.

*See "Power" 1917, Jan. 30, p. 142; Mar. 6, p. 325; Apr. 3, p. 463; May 22, p. 707; May 29, p. 748; July 17, p. 96; Sept. 18, p. 399; Dec. 11, p. 806. The illustrations were inadvertently omitted from this letter as published in "Power" of Apr. 2. Therefore it is reprinted here.

## Testing Field-Pole Polarity.

In putting into service a new generator or motor or one that has been repaired, it frequently requires considerable testing to find whether the field poles have correct polarity; that is, alternate north and south poles. The figure shows a simple way of determining the correct polarity. First, excite the field coils and then take two wire nails and placing their points on adjacent polepieces, then bring their heads close together, as in the figure; if they attract, the poles are the correct polarity, since unlike poles attract. On the other hand, if the nails repel each other, the polarity of the polepieces is wrong and must be corrected by interchanging the lead on one field coil. In this way it requires only a few minutes to examine the whole machine




FIELD FRAME, SHOWING TWO NAILS IN POSITION TO TEST FIELD-POLE POLARITY

New York City. D. R. HIBBS.

# Inquiries of General Interest

**Relative Dimensions of Extra-Heavy and Standard Pipe**—Is the difference in thickness of extra-strong pipe and tubing from that of commercial standard pipe and tubing in their variation of inside or outside diameter? J. L.

The greater thickness of the extra-heavy pipe and tubing is provided by having smaller actual inside diameter than the same nominal size of standard pipe, the external diameter being made the same so as to be suitable for standard-pipe screw threading.

**Pressure Equivalent to Zero Inches Vacuum** — When a vacuum gage shows 0 inches of vacuum, what is the pressure? R. A. S.

"An inch of vacuum" signifies one inch of mercury column pressure less than the pressure exerted by the atmosphere. Hence the pressure for zero inches of vacuum would be the same as zero gage, or the pressure of the atmosphere above a perfect vacuum, which, unless otherwise qualified, is assumed to be equivalent to the intensity of pressure exerted by a column of mercury 30 in. high when at the temperature of 62 deg. F., or an absolute pressure of 14.7 lb. per square inch.

**Length of Open Belt**—What would be the length of an open belt to go around pulleys respectively 8 ft. and 4 ft. 6 in. diameter and 24 ft. center to center? H. C. B.

The approximate formula for obtaining the required length is

$$L = 2C + \pi\left(\frac{D+d}{2}\right) + \frac{(D-d)^2}{4C}$$

where

$L$ = Length of open belt;
$C$ = Distance center to center of pulleys;
$D$ = Diameter of larger pulley;
$d$ = Diameter of smaller pulley.

By substituting,

$$L = (2 \times 24) + 3.1416\left(\frac{8+4.5}{2}\right) + \frac{(8-4.5)^2}{4 \times 24} = 67.76$$

or practically 67 ft. 9 in.

**Latest Cutoff of Single-Eccentric Corliss Engine**—In ordinary operation of a single-eccentric Corliss engine, why cannot cutoff take place later than one-half stroke? F. E. G.

Each exhaust valve must be opened and closed by a forward and backward motion of the wristplate to one side of its central position during one stroke, and as the operation must be accomplished during 180 deg. of the revolution of the shaft, the motion of the wristplate to one side of the central position must occur during 90 deg. of the revolution, or about one-half of the stroke of the piston. As a steam valve must not open until the exhaust of the same end has closed, and cutoff must be effected by the cutoff cam while the steam valve is carried by the wristplate in the initial direction for opening, and before the wristplate begins to return toward the central position, cutoff cannot occur later than 90 deg. of revolution of the eccentric, from the time the wristplate is in its central position or about one-half stroke of the piston.

**Setting Common D-Slide Valve**—What is the method of setting the valve of an ordinary D-slide-valve engine? A. N.

Uncover the valve chest and adjust the length of the valve rod so each end of the valve will overtravel the steam ports the same amount, either from turning the engine over with the eccentric fastened to the shaft or from turning the loosened eccentric all the way around the shaft. Then put the engine on a center and set the eccentric at such a position on the shaft that, with forward direction of rotation of the shaft, the end of the valve would begin to uncover the steam port on the end of the cylinder that contains the piston, or set the eccentric forward far enough to obtain the desired amount of lead opening. The engine should then be turned over on the other center to ascertain whether the same amount of lead has been obtained for the other end of the valve. If not, take out one-half of the difference by readjustment of the length of the valve rod. If more lead is desired for both ends, it can be obtained by shifting the eccentric forward on the shaft or less lead by shifting it backward.

**Whole-Coil and Half-Coil Windings**—What is the difference between a whole-coil and a half-coil winding? A. R.

In concentrated winding sometimes used on alternating-current machinery, a whole-coil winding is one in which

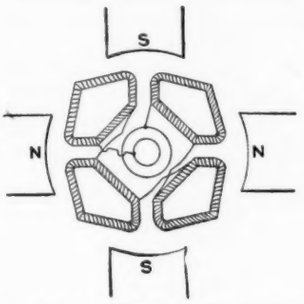



FIG. 1. WHOLE-COIL WINDING

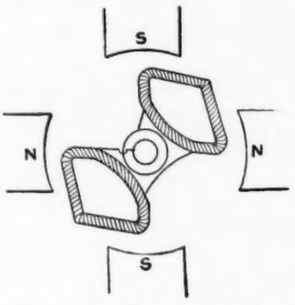



FIG. 2. HALF-COIL WINDING

there is one complete turn or coil per phase per pole, as in Fig. 1. A half-coil winding is one which has only one complete turn or coil per phase per pair of poles, as in Fig. 2.

**Advantage of Inclosing Heating Returns**—When steam at 105-lb. gage is supplied to drying coils in which the pressure is maintained at 5 lb. gage, with the condensate discharged against atmospheric pressure and returned to the boiler at 180 deg. F., what percentage of saving would be effected by returning the condensate under 5 lb. pressure? H. L. W.

If the coils discharge direct to the atmosphere without being trapped, no comparison of economy can be made without knowing the percentage of steam thus wasted. If the present discharge consists only of condensate that is formed in the coils and returned to the boiler at 180 deg. F., then as one pound of steam at 105-lb. gage or 120 absolute contains 1189.6 B.t.u. above 32 deg. F., for reconversion into steam each pound of the return water must receive from the boiler 1189.6 − (180 − 32) = 1041.6 B.t.u. The relatively small amount of heat that would be saved by reason of supplying the boiler feeder with water at 5 lb. higher pressure can be neglected. The principal consideration would be the temperature of the returns as received by the boiler. The temperature of the condensate when formed in the coils would be the same as the temperature of dry saturated steam at 5 lb. gage, namely, about 228 deg. F., but there would necessarily be some reduction of this temperature in handling the returns. Assuming that the actual temperature of the condensate as returned to the boiler is 220 deg. F., each pound of steam generated would require 220 − 180 = 40 B.t.u. less than with the feed temperature at 180 deg. F. and the saving would be 40 × 100 ÷ 1041.6 = 3.84 per cent., practically 1 per cent. for each 10 deg. temperature of the feed in excess of 180 deg. F.

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[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

# Central or Independent Power Service*

BY FREDERICK B. KENNEY†

*A survey of the reasons for the development of the central electric light and power industry. Discussion of the paper is given.*

THE term "central station" has today lost, through popular application to central stations for the distribution of electric light and power, its inclusiveness of all central sources of supply of a commodity or service essential to the well being of a community. In the widest significance of the term can be included all central sources of supply which time and economic conditions have developed through a knowledge and realization that certain essentials can be manufactured, developed or supplied to best advantage on a coöperative or community-of-interest basis.

The coöperative store is perhaps the first central station worthy of note, followed by the metropolitan water system, the central gas plant, the central electric light and power plant, and finally by the utilities for the transportation of ourselves or our goods, for either short or long distances.

### THE CENTRAL STATION A NATURAL DEVELOPMENT

The central station is the natural development of such realization, for while each family in a community could today maintain a private well for its water needs, the absurdity of attempting this for any reason is apparent. Again, the family which once was content to make its own tallow dips could today maintain its own little acetylene-gas plant, but where such a plant can be found within the territory supplied with illuminating gas from a central gas plant, common sense is not one of the factors responsible for its maintenance. The same argument can be applied to our transportation needs, for were we as individuals compelled to rely today upon our physical ability to fill them, we would indeed be sadly limited in our travels and in all supplies not available in our immediate vicinity.

Centralization is decidedly apparent in manufacturing, for the origin of all manufactured articles can be traced to the individual home until demand and economic needs developed the factory.

To confine ourselves to the popular interpretation of the term "central station" and to attempt to compare its value with that of the "isolated plant," a knowledge of the history and development, with a full realization of the field occupied by each, is essential. Since light, heat and power are the products of each, a slight review of the present and past needs is not out of place.

In the Eighteenth Century Newcomen produced the first steam engine which seemed commercially practicable. A number of these engines were installed for pumping purposes in the mines of England, but not until late in the same century was the steam engine, as we recognize it today, placed on the market by Watt and his associates.

It is of interest to note that at this period illuminating gas was developed from coal by a Scotchman named Murdoch and utilized in the shop of Boulton and Watt in Birmingham, England. Shortly following, London Bridge was illuminated with coal gas, and for the distribution of this new illuminant was born the central-station idea coincident with the prime mover which is today the backbone of the isolated plant.

The steam engine as improved by Watt found a receptive field in various industrial plants, notably in the cotton industry, which at this time in England was rapidly undergoing radical changes in mechanical equipment. The beam type was accepted as standard until the middle of the Nineteenth Century, at which time the horizontal type came into favor, followed shortly by the Corliss type, which with certain refinements, is standard today.

Though engines of many types and arrangements of valve gear appeared from time to time, the reign of the heavy slow-speed engine was undisputed until 1879, when the perfection of the incandescent lamp by Edison ushered in a new phase of the light and power problem and gave birth to the electric central station as it is popularly known. The need of high-speed engines to drive the new generators devised by Edison was first met with an engine designed by Edison himself, followed by engines of other manufacturers quick to realize the possibilities of the new incandescent lamp. Designers of the steam turbine renewed their efforts to perfect their machines.

Late in 1882 was established in Appleton, Wis., the first central electric-light station for the distribution of electricity. Curiously enough this little station of 250 ten-candlepower lamp capacity was a hydro-electric plant, the generator being driven by a waterwheel. This seems almost prophetic of what to many seems to be the ultimate of economic efficiency with such apparatus as is now available.

The following year saw the establishment of central stations in many of the larger cities, and the demand throughout the country for such service for a while exceeded the ability of the manufacturers to supply the necessary apparatus and lamps.

The growth of the central station from that time has been rapid and is perhaps best reflected in such figures as are available from the Federal Census since that date as follows:

| Commercial Only | 1902 | 1907 | 1912 |
|---|---|---|---|
| Central stations | 2,805 | 3,462 | 3,659 |
| Kilowatt capacity | 1,099,000 | 2,500,000 | 4,766,000 |

Figures for 1917 are not yet available, but it is interesting to note that while the total number of stations in 1912 had increased by less than 6 per cent. over the total of 1907, the total capacity had increased by over 90 per cent. This rate of increase has probably been maintained during the last five years, and it is reasonable to suppose the present total capacity approaches very closely 9,000,000 kilowatts.

Development of the electric motor, together with consolidations, reorganizations and centralization of management, soon put the central station upon a solid foundation and direct competition with the isolated plant was the inevitable result. With the large field for power opened to the central station by the electric motor, a greater output over which to spread overhead charges resulted. With increased demands, larger units followed, with higher efficiencies and lower operating costs. Some idea of the net results relative to steam prime movers and motors operated with purchased current in industrial plants can be obtained from the census figure for the years 1899 and 1909 as follows:

| Capacity In | 1899 | 1909 |
|---|---|---|
| Steam generated power, horsepower | 8,200,000 | 14,200,000 |
| Purchased electric, horsepower | 182,500 | 1,750,000 |
| Total of both sources | 8,382,500 | 15,950,000 |

While the total capacity in steam power had increased by 75 per cent., the total purchased power had increased by 960 per cent., and whereas the purchased power in 1899 was a trifle in excess of 2 per cent. of the total, in 1909 it had become in excess of 11 per cent. of the total. Figures for the last eight years will no doubt prove equally as creditable to the central station.

Meanwhile the sponsors for the isolated plant have not been idle and, profiting by the experiences of the central station, have disposed of obsolete equipment, eliminated wasteful methods of transmission, installed modern and efficient equipment and taken measures to obtain the maximum economies possible. For these the day of surrender to central-station service is deferred, but not entirely eliminated. For the plants that have not profited by the experiences of the central station and have neglected to im-

*A paper before the Providence Engineering Society, Providence, R. I., Jan., 1918.

†Mechanical Engineer, Blackstone Valley Gas and Electric Co., Pawtucket, R. I.

prove their conditions, the handwriting on the wall is clear. There always will be exceptions to this probability, dependent upon peculiar and local conditions.

Probably no better method of outlining the truth of this can be employed than to apply the arguments for and against central-station service to a typical plant familiar to the writer. The plant in mind furnishes light, heat and power for a cotton mill of the usual type, spinning its own yarn and utilizing it all in the weaving of plain cotton fabrics.

The engine plant consists of two old Corliss cross-compound engines operating condensing, one of approximately 1200 hp. rating and the other of approximately 600 hp. rating and both about thirty years of age. Transmission is mechanical throughout. Steam is furnished from a battery of water-tube boilers. Heating is done with live steam. A mixture of about one part bituminous to three parts buckwheat coal is burned. The average load carried approximates 1400 i.hp. The actual operating costs for the year 1912 were $25,000, which includes no overhead charges, with slight repair or maintenance charges. The engineer in charge is a most capable man and is obtaining results that could hardly be bettered with any apparatus that could be installed. The physical conditions in transmission are, however, extremely bad, and fully 40 per cent. of the power generated is dissipated in friction. It is estimated that 900 hp. in motors would handle this mill to much better advantage than it is being handled at present. With 2,000,000 kw.-hr. per year at 1c. per kw.-hr., the cost of current to this mill would be $20,000; overhead charges on motor equipment (based on 1912 figures), $1500; heating and all other charges, $6500; total, $28,000; apparent balance in favor of the isolated plant, $3000 yearly.

Eventually, this plant for physical reasons must be replaced. At such time overhead charges must be considered, and assuming the installation of a 1000-kw. plant with a minimum cost of $100,000, the immediate yearly burden approaches $12,000. Add to this the item of $1500 burden on motors and $6500 for heating and incidental operation, a total of $20,000 is chargeable to the power plant before the generation of a single kilowatt. Since the central-station price for the service is estimated at $28,000, $8000 is available for the generation of 2,000,000 kw.-hr., necessitating a generation figure of $0.004 per kw.-hr. Assuming this new plant operated at an economy of 2.5 lb. of coal per kw.-hr., with coal at $3.50 per ton as in 1912, the resultant coal charge becomes $7700.

Similar illustrations could be furnished, but probably this is sufficient to illustrate the facts where the average industrial plant is concerned. In considering hotels, bleacheries and plants where the utmost use of exhaust steam can be made, different conditions are encountered which make it more difficult for the central station to justify abolishing the isolated plant, but since the same is being done daily, it would seem that such action in many cases can be justified. However, in each of such cases, the proper course can be determined only by individual analysis. Aside from all the considerations outlined, the question of coal supply is important. Reverting to the case of the mill outlined, the total coal required for power purposes in this mill was in excess of 4000 tons yearly. To furnish 2,000,000 kw.-hr. yearly to this plant the coal required by the central station would approximate 2000 tons. The application of this ratio to the requirements of the many isolated plants throughout the country furnishes abundant food for thought in view of the present coal situation.

In conclusion, it must be apparent that in the mind of the writer the isolated plant, except for isolated cases where geographical or peculiarly local conditions prove the exception to the rule, is surely bound toward central-station service. The day for a large number of plants may be long deferred, but eventually economic efficiency will prevail.

## Discussion

*Warren B. Lewis*, consulting engineer, Providence, R. I.: If, before I finish, I appear to be harshly critical of some of the features of Mr. Kenney's very excellent paper, it will not be by reason of antagonism to either the speaker or his subject, but will arise from an attempt to emphasize the weakness of some of the arguments advanced for and against central-station service.

Mr. Kenney says that this is an era of centralization. This is the strongest argument that he uses, and I think that he might have carried it farther by saying that there is no more reason why manufacturers should generate power than that they should enter into the business of manufacturing the raw materials that they use. Up to within a few years ago it was necessary that they should manufacture their own power because they could not get it any other way; and I venture to say that most of them have always considered it as one of the most irritating departments of their business and looked upon it as a "necessary evil." Now that they can purchase power delivered f.o.b. their factory, there would seem to be little excuse for considering any other method. Power bears no relation to manufactured product as far as being a constituent element; and specialization is as logical in the manufacture of power as it is in the manufacture of machinery or textiles.

Again, there is little justification in investing one's money in power plants as a mere department of one's regular business on the basis of a net return of 5 or 6 per cent. (which is the rate usually charged into the costs), when the same amount of money would probably earn from two to three times that amount when invested in the business itself. However, while these are perfectly good arguments, they are very general ones; and, after all, the question is not the central station vs. the isolated plant, but it is the central station vs. some particular isolated plant.

Mr. Kenney, for instance, states that for one to maintain a private well for his water needs would be an absurdity from any viewpoint. Private wells are quite general in the midst of large cities, and the matter is purely one of the amount of water used and the cost of pumping it. It certainly would be an absurdity for each individual family to run its own water-works as suggested, but it is not an absurdity for an individual who needs large quantities of water at a fairly uniform rate of flow. So with other facilities. Expediency of individual effort is determined largely by the particular characteristics of the case in question.

Mr. Kenney goes on to give the history of the development of steam engines and the electric-lighting industry, arriving ultimately at the conclusion that the huge units made possible through the centralization of the power business have brought about efficiencies that could not be attained by the individual producer. This is true when referred to small users, but is not always true in the case of the larger users. Furthermore, the centralization of the industry has added expenses of distribution, management, cost accounting, investigation, research, etc., which makes the actual cost of power at the point of generation a comparatively small percentage of the whole. These expenses, not being incidental to the cost of the power produced by the individual, are in many cases a handicap.

If we are to indulge in general arguments, it is safe to say that the cost per unit of power installed must, in the case of the central station, be as great, if not greater than for the case of an isolated plant of considerable size, when one takes into consideration the investment in auxiliary equipment, distributing systems, real estate, etc. The central station must earn fixed charges, as well as the isolated plant; and if there is any advantage in this respect it is that the central station can figure lower fixed charges than can the isolated plant.

From the viewpoint of running costs, I doubt whether the pounds of coal consumed per kilowatt-hour are much, if any, less in stations of from 25,000 to 30,000 kw. than in many textile plants of a thousand kilowatts. Here again Mr. Kenney might have emphasized the fact that the central stations have a corps of technical experts who are constantly studying problems of economy where the usual isolated plant does not, and that the central station will maintain its efficiency for a much longer time than will the isolated plant; and therefore, the figures for the latter, previous to its installation, may not be of much weight five years after.

Mr. Kenney goes on to cite the case of a cotton mill. I find the figures rather general, which always leaves one in

doubt as to whether any conclusions can be drawn after all. He admits at the start that the plant had a most inefficient drive and was wasting 40 per cent. of the power generated. Whether this mill continued to make its own power or purchased it, it is evident that it would have to spend considerable money not only to install motors but to rearrange entirely its shafting, belting, etc., to reduce the load from 1400 to 900 hp.; and the expense would be put upon the mill in any event. The real comparison would then come as to whether power could be purchased at the switchboard at the price at which it could be made in the isolated plant; and it would not be necessary to take into consideration overhead charges on motor equipment, shafting, etc., nor on heating or steam used for processes.

He quotes a price of one cent per kilowatt-hour; but few of us have realized the benefits of any such price, even on total bills aggregating $20,000 a year. Most rates are based on a service charge and a running charge, and the service charge is generally much higher than the fixed charges placed on isolated equipment. I am assuming that for a mill using 1000-kw. maximum demand, the service charge would probably be $15,000 a year, which is $3000 more than the burden that he places on a 1000-kw. isolated plant. If the service charge is $12 per kw., then the burden becomes the same. Through the advantages of the diversity factor, the central station realizes very much greater revenue from service charges than is at first apparent. I venture to say that if the total maximum demand billed to all customers was added together, it would greatly exceed the actual maximum demand of the central station, owing to the peculiar workings of the diversity factor.

Mr. Kenney refers to plants where exhaust steam can be used, as presenting a more difficult problem for the central station. He could have made a strong point for his case in this particular direction, by showing that few plants use as much exhaust steam as they think they do, and that many use exhaust steam most inefficiently just because they have it, and then console themselves with the thought that they are operating economically. There is many a plant that, if it started with its uses of exhaust steam and reduced them to the actual minimum requirements, would find that the supposed efficiency had disappeared.

With reference to the economic consideration it is hardly fair to compare the central-station requirement of 2000 tons with the mill requirement of 4000 tons. The 4000 tons referred to were admittedly more than should have been the case; and then one must not forget slashers, heating and other equipment which require the use of coal.

It might be interesting, in connection with this paper, to cite the case of a cotton mill having a generating equipment of 1250 kw. and a modern and efficient plant throughout. The heating of the mill was a very considerable item, owing to the peculiar processes carried on. The mill was heated by the use of a hot-water system, the water in turn being heated by live steam on the theory that the temperature of the mill could be nicely controlled with varying temperatures out of doors. Investigation developed that it was possible to heat the water in the hot-water system by using the surface condenser as a water heater; or, to put it another way, by using the water in the heating system as the circulating water for the condenser. It was found possible to vary the temperature of the circulating water by varying the load on the turbine and carrying varying degrees of vacuum. The net result was the production of 300 kw. with the steam previously used for heating purposes alone. It is quite probable that the saving that can be effected during the heating season through this method of operation would justify the operation of the plant the whole year round even in the face of extremely low rates for central-station current.

## Engine-Room Design

The engine room is universally recognized as a hazardous department. Admittance is denied even to the initiate except when required by their duties.

It is because of this condition that great care should be exercised to guard against accidents. In many ways this care is noticeable. Engineers are experienced, trained specialists who recognize the potential destructiveness of their machines. Engines are the product of the highest type of engineering skill and have been perfected to an extent equalled in few other branches of mechanical construction. The efforts of the best designers are centered on producing material surroundings within which the heart of the plant may beat safely and with the greatest efficiency.

An engine room should have at least two means of entrance and exit, each of which should be easy of access and within reasonable view of the engineer in charge. (Too many entrances, however, for obvious reasons, are inadvisable.) All passageways and exits should be free of obstructions, and doors should open outwardly and should not be so close to operating equipment as to create a hazard. Basements of engine rooms should have exits so arranged that men may not be trapped in the basement.

A sign should be conspicuously posted outside each doorway forbidding entrance except on business.

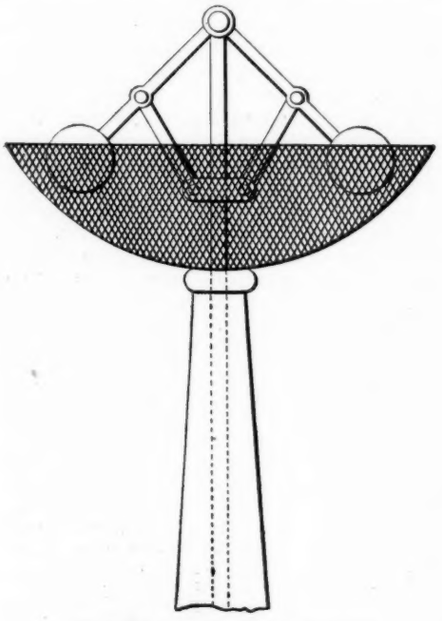
If entrance ways are kept open for ventilating or other purposes, bars or gates should be placed across the entrance.

A gallery for visitors is sometimes provided, as the department exercises a fascination for plant visitors. Entrance to such a gallery is preferable by an outside stairway. If entrance to the gallery is from the main entrance, substantial guard and intermediate rails should clearly prescribe the limit of welcome, and signs indicating entrance to gallery should be displayed. The gallery or balcony should be of fire-resisting construction, rigidly built, and should be securely railed to a height of at least 42 in., with intermediate rails and toe-boards, or the space between the top rail and floor entirely filled in. Conversation between visitors in gallery and engineers or assistants in room below should not be permitted.

Floor of engine room should be of concrete or abrasive surface to eliminate the slipping hazard. When approach is had to any engine or machine, the nonslipping provision should be emphasized. Frequently, inserts or mats of nonslip material are used at these points when the entire floor is not of nonslip material.—*National Safety Council.*

## Flyball Governor Guard

A hemispherical sheet-metal or wire-mesh basket strong enough to hold the balls in case of breakage, placed under the flyballs as shown is a useful guard and is absolutely



FLYBALL-GOVERNOR GUARD

necessary if the governor encroaches at all upon a passageway or a position occupied by an attendant in the performance of his duties.—*National Safety Council.*

# Gasoline Substitute Full of "Pep"

Dr. Lewis Clements, who claims to have produced a substitute for gasoline at a cost of 2¼c. per gal., gave a demonstration in New York on Mar. 19. First of all, the doctor was arrested recently on complaint of a party who had been induced to invest in the substitute that could not, it was claimed, be made for the price stated, and the police agreed to this contention. The district attorney, however, gave the doctor a chance to prove that this substitute would work.

According to the New York *Sun* the thing that sticks in the crop of Assistant District Attorney Renaud is that all the chemists who looked over Doc Clement's formulas said that when it came to producing a low-cost fuel the Standard Oil Co. was an eleemosynary institution compared to the doctor.

They admitted that something ought to happen when all that benzine, alcohol, kerosene, naphtha, sugar and sulphuric acid was poured into a gas tank, but they didn't see how the Doc could make it even at his revised figures of 8c. a gal. They said that solemnly and with forethought, and then put their names after it and went away, so that the Doc was really licked before he started.

It wasn't his fault. He picked things up and put them down, washed them out and then washed them again, sipped kerosene as if he liked it every time he started a siphon working, spilled benzine and alcohol and naphtha all over the place, built little fires and put them out again, and generally had a lovely time. It was the verdict at the ringside that the Doc put up a game fight.

Before the show began, however, the chemists herded the Doc off in a corner and got his formula. Then they deliberated for about an hour and produced the following:

At the request of Mr. Renaud we have today conferred with a person introduced to us by Mr. Renaud as Louis Clement (they weren't taking any chances), and have received from said Clement a statement of what he declares to be a full and complete formula for his motor fuel.

We know that a motor fuel made according to said formula will cost more than 2½c. a gal., which you stated said Clement represented that it would cost, and further that it would cost much more than 8c. a gal., as said Clement represented to us today.

In our conference with said Clement we noted that he used chemical terms incorrectly, and he did not impress us as possessing scientific or technical knowledge of the subject. Signed: Charles Baskerville, Charles F. McKenna, Gustave W. Thompson, Francis P. Smith, J. C. Olsen, William Gies.

With which deathbed bulletin they all went away save Dr. Gies, who is professor of biological chemistry at Columbia University, and who waited till the bitter end. This pronouncement did not bother Doc Clement a bit. He listened to it being dictated to the reporters waiting to give the news to expectant owners of little flivvers, and then rolled up his sleeves, removed his hat, but kept his overcoat on.

To show that he had nothing concealed about him the Doc permitted detectives to search him in the most approved manner of the stage. He got behind his big board table and proceeded to unwrap, and as he did so it was hard to make out whether the Doc was going to take up light housekeeping or not.

This is what he produced:

| | |
|---|---|
| Four glass gallon jars | One oil can |
| Ten test tubes | One bottle sulphuric acid |
| Four graduated glasses | Nine corks |
| Two glass funnels | One bunsen burner |
| More corks | Two boxes talcum powder |
| One can of alcohol | One wash boiler |
| One washtub | One bag of sugar |
| One bottle of cedar oil | One package of alum |
| Sodium bicarbonate | Alcohol stove |
| Weighing scales | Thermometer |
| Five rubber tubes | More test tubes |
| Two towels | Three gallons distilled water |
| One pair of scissors | Four gallons kerosene |
| One piece of chamois | One suit case |
| Two porcelain spoons | |

To these were later added a Stillson wrench, an oil stove, which was purchased halfway through the experiment, a cut on the hand acquired by the Doc in opening the kerosene can, a frown and a bad taste from drinking kerosene.

Just to make the scene a bit more reminiscent of Mr. Kellar, Assistant District Attorney Renaud opened some of the packages with an explanation something like this:

Gentlemen, in this package we have talcum powder, or what purports to be talcum powder. Is it talcum powder? It is. Martini, pour it back.

Hours and hours had gone by and the spectators shifted about, watching the doctor unpack and get ready, and listened to his attorney, William Bosler, explain that the Doc hadn't eaten a thing since the night before and had only slept an hour in four days.

No blushing debutante ever awaited the hour of appearance with greater trepidation than the urbane Dr. Clement. He finally got started about 1:20 and at 1:56 had his picture taken, with cries of "Look thoughtful, doctor!" from the photographers.

### He Gives 'Em a Little Action

1:57. Weighs graduated glass excitedly.

1:58. Rubs talcum powder on the graduated glass and puts it down.

2:00. Somebody says, "What does the labor cost?"

2:01. Pours water into a jar.

2:02. Pours it into another jar. Movie machines clicking.

2:03. Puts naphtha flakes, the stuff mothballs are made of, into a graduated glass. More movie activity.

2:05. Little bird up in the rafters says: "Tweet, cheep, tweet."

2:07. Puts sulphuric acid in glass and pours in cedar oil. Stirs it violently while it turns red. Movie men angry because their machines won't take red.

2:11. Assistant district attorney eats a sandwich.

2:15. Mixes oil and water. Somebody explains that the cedar oil gives the car a woody smell so that in driving through Central Park the squirrels will follow the car.

2:25. The Doc siphons kerosene and gets a mouthful.

2:26. Assistant district attorney takes seat on a motor truck to referee the match.

2:38. Drinks more kerosene. Somebody denies the rumor that he has it for breakfast instead of orange juice.

2:40. Makes salad dressing of kerosene and sugar, lights the mixture and then throws it away. Look of perplexity on the faces watching.

2:41. Mixes water and alcohol and burns it.

2:42. Puts benzine in the wash tub.

Then hours and hours and hours while search is made for a stove to heat the mixture which has been consigned to the wash tub. People go in and out and send for more lunch. The stove is produced and the firemen run in a hose from the hydrant outside. Nothing happens. The stuff is stirred up by the doctor with a thermometer and he announces that it is cooked. It is strained and ready for the experiment.

Outside a big two-ton fire truck had been prepared for the experiment. A gallon can with connections all in sight was fastened above the engine and the mixture, which was a pale lemon color, with little bubbles of what a chemist said was water, was poured in. Battalion Chief Marshall superintended this and when the Clement mixture had been poured in, a large husky workman was detailed to turn over the engine.

He turned. Nothing happened. He turned and turned and turned. Still nothing happened. Then he tinkered with the carburetor, and turned some more. Not a kick. The engine was primed and the exhausted cranker relieved by another, but still no response.

Deep gloom and words of indignation on the part of Doc Clement's attorney and friends. The engine should not have been cold; the water in the radiator was cold; it was not fair.

"Let me try the flivver," said the doctor. It was permitted, and with a few deep inhalations the engine raced as if it had picric acid in its innards. Large clouds of smoke drifted from the exhaust and brought back memories of kerosene lamps in the days of one's youth.

One recalled that according to Don Marquis a flivver will run on Stutter's Stomach Bitters, Stewroona, Doctor Bunkus' Discovery for the Kidneys, Lily Gingham's Discovery or Siwash Injun Soorah. It seemed even so.

It was tried on a six-cylinder car with a self-starter and worked beautifully, but all the efforts of Chief Marshall's mechanics would not cause that fire-department machine to cough once. The chemist explained that it was because the water had dissolved and settled to the bottom and no engine will run on water, except apparently a Ford. So the experiment ended, with both sides claiming victory.

But the scientific gentlemen were all on the side of the district attorney, for they showed that all the ingredients in the mixture, with the exception of kerosene, cost as much as gasoline—some of them more. Kerosene costs less, but even that is 15c. per gal., and the Doc claims he can make his stuff for eight cents. He produced at the test from the $9 worth of material about 5 gal. of substitute.

## No Strikes or Lockouts During the War

The War Labor Conference, which has been in session at Washington for several weeks, on March 29 submitted to Secretary of Labor Wilson a comprehensive program for the settlement of industrial disputes during the war period, by means of which, if adopted, lockouts and strikes would be averted and production kept at a maximum. Under the proposed agreement, the right of workers to organize in trade unions and to bargain collectively is unreservedly recognized and the open shop is also protected; the basic eight-hour day is recognized; the right of all workers to a living wage is guaranteed; and women doing the work ordinarily performed by men are to receive the pay of men.

In case of disputes there is to be investigation and arbitrament by a National War Labor Board to consist of five representatives of capital and five representatives of organized labor. If the efforts of the National Board fail to bring about a voluntary settlement, provision is made for the appointment of an umpire by the unanimous vote of the National Board. Failing such choice, the name of the umpire shall be drawn by lot from a list of ten suitable and disinterested persons to be nominated for the purpose by the President of the United States. This umpire shall have power, under simple rules of procedure prescribed by the National Board, to make final decisions, from which there can be no appeal.

Ex-President William H. Taft and Frank P. Walsh, selected counsellors respectively of capital and labor, in statements made on Saturday, gave their full approval to the recommendations of the board.

### Rules of Procedure

The principles and policies to govern relations between workers and employees in war industries for the duration of the war are stated substantially as follows:

There should be no strikes or lockouts during the war.

The right of workers to organize in trade unions and to bargain collectively, through chosen representatives, is recognized and affirmed.

The right of employers to organize in associations of groups and to bargain collectively, through chosen representatives, is recognized and affirmed.

Employers should not discharge workers for membership in trade unions, nor for legitimate trade-union activities.

The workers shall not use coercive measures of any kind to induce persons to join their organizations nor to induce employers to bargain or deal therewith.

In establishments where the union shop exists, the same shall continue and the union standards as to wages, hours of labor and other conditions of employment shall be maintained.

In establishments where union and nonunion men and women now work together and the employer meets only with employees or representatives engaged in said establishments, the continuance of such condition shall not be deemed a grievance. This declaration, however, is not intended in any manner to deny the right or discourage the practice of the formation of labor unions or the joining of the same by the workers in said establishments, nor to prevent the War Labor Board from urging, or any umpire from granting, under the machinery herein provided, improvement of their situation in the matter of wages, hours of labor, or other conditions.

Established safeguards and regulations for the protection of the health and safety of workers shall not be relaxed.

If it shall become necessary to employ women on work ordinarily performed by men, they must be allowed equal pay for equal work and must not be allotted tasks disproportionate to their strength.

The basic eight-hour day is recognized as applying in all cases in which existing law requires it. In all other cases the question of hours of labor shall be settled with due regard to governmental necessities and the welfare, health and proper comfort of the workers.

The maximum production of all war industries should be maintained and methods of work and operation on the part of employers or workers which operate to delay or limit production, or which have a tendency to artificially increase the cost thereof, should be discouraged.

For the purpose of mobilizing the labor supply with a view to its rapid and effective distribution, a permanent list of the number of skilled and other workers available in different parts of the nation shall be kept on file by the Department of Labor, the information to be constantly furnished: (1) By the trade unions; (2) by state employment bureaus and Federal agencies of like character; (3) by the managers and operators of industrial establishments throughout the country. These agencies should be given opportunity to aid in the distribution of labor, as necessity demands.

In fixing wages, hours and conditions of labor regard should always be had to the labor standards, wage scales and other conditions prevailing in the localities affected.

The right of all workers, including common laborers, to a living wage is hereby declared.

In fixing wages, minimum rates of pay shall be established which will insure the subsistence of the worker and his family in health and reasonable comfort.

## Fuel Administration's Fuel-Oil Rules

President Wilson, acting through the United States Fuel Administrator, on Mar. 25, promulgated revised rules and regulations governing the distribution of fuel oil in that section of the United States east of the Rocky Mountains. These regulations supersede those issued Jan. 31, 1918.

Under a proclamation issued by the President Jan. 31, every manufacturer and distributer of fuel oil (including gas oil) whose gross sales aggregate more than 100,000 bbl. per annum was required to secure a license from the Fuel Administration on or before Feb. 11, 1918. The regulations promulgated Mar. 25 control these licensees.

The reason for revising the regulations is that under the former provisions it was found that distributers controlling only a small supply of fuel oil were unable to meet the requirements of all their customers. Distributers controlling larger supplies were able to meet the requirements of all consumers on the priority list. This situation worked a hardship to the customers of the smaller distributers and deprived essential industries of their fuel oil.

Under the new regulations if a distributer is unable to meet the requirements of all of his preferred customers, another distributer may be required by the Fuel Administration to meet this demand before he is allowed to supply his own customers who are not on the preferred list.

Twelve classes of consumers are specified in these regulations, and manufacturers and distributers are required to give priority in the distribution of fuel oil to them in the order in which they are named.

Deliveries must be made in conformity with this list regardless of any existing contracts between licensees and consumers in other classes. After the requirements of consumers entitled to priority are satisfied, licensees must carry out their contracts for other deliveries to the extent of their supplies.

These rules and regulations are for the purpose of assuring an adequate supply and equitable distribution of fuel

oil for purposes vitally essential to the national security and defense and to the successful prosecution of the war.

The shortage in the amount of fuel oil which can be delivered, because of transportation conditions, is such that it is clearly a wasteful and unreasonable practice to deliver such fuel oil for uses which are not intimately and directly connected with the prosecution of the war.

*Rule 1.* No licensee engaged in the distribution of fuel oil in that part of the United States east of the Rocky Mountains shall, without the consent of the United States Fuel Administrator, make any deliveries of fuel oil to any customer or consumer of any one of the classes mentioned below, whether the licensee is under any contract to make delivery to such customer or consumer or not, until such licensee shall have delivered to the customers or consumers of every class designated by a lower number with whom such licensee may have contracts, or to whom such licensee shall have been directed to deliver by order of the United States Fuel Administrator, all fuel oil to be delivered upon such last-mentioned contracts or such orders of the United States Fuel Administrator. Preferential deliveries as between members of the same class may be made only with the consent and under the direction of the United States Fuel Administrator. This rule shall apply to all deliveries of fuel oil, regardless of any contracts therefor or hereafter made.

Provided that this rule shall not prevent the delivery of fuel oil by any licensee to any jobber or distributer if such fuel oil is to be used for a purpose for which the licensee could deliver such oil direct, nor in any case where the jobber or distributer shall have been licensed or designated by the United States Fuel Oil Administrator.

The classes referred to and the order of their preference are as follows: (1) Railroads, bunker fuel and oil refineries using or making fuel oil; (2) export deliveries or shipments for the United States Army or Navy; (3) export shipments for the navies and other war purposes of the Allies; (4) hospitals where oil is now being used as fuel; (5) public utilities and domestic consumers now using fuel oil (including gas oil); (6) shipyards engaged in Government work; (7) navy yards; (8) arsenals; (9) plants engaged in manufacture, production and storage of food products; (10) Army and Navy cantonments where oil is now being used as fuel; (11) industrial consumers engaged in the manufacture of munitions and other articles under Government orders; (12) all other classes.

*Rule 2.* Licensees shall promptly comply with all orders of the United States Fuel Administrator with respect to the delivery of fuel oil, the submission of reports, and other matters proper and necessary to carry into effect the President's proclamation of Jan. 31, 1918.

*Rule 3.* Neither these rules and regulations nor the orders of the United States Fuel Administrator shall relieve any licensee from his obligation to deliver fuel oil which he has contracted to deliver as soon as the prevention resulting from such rules, regulations, or orders shall have ceased to operate and the fuel oil shall be available for delivery under such contracts.

These rules and regulations shall apply to all licensees heretofore or hereafter licensed under the proclamation of the President dated Jan. 31, 1918, and shall supersede the rules and regulations issued with the approval of the President on that day.—H. A. GARFIELD, United States Fuel Administrator.

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Speaking recently at Dewsbury on coal conservation, W. B. Woodhouse, chief engineer and manager of the Yorkshire Electric Power Co., said that in the United States the production of coal per man was 660 tons, as against 250 tons in Great Britain; in the textile clothing trade, the annual value of the production per person employed in the United States was £484, as against £158 in Great Britain; the primary cause for the difference was that American industry used approximately three times as much power as was used here in corresponding trades. The solution of the problem was the more economical use of fuel and the cheapening of power supply, the one being a consequence of the other.—*Engineering (London).*

# Syracuse Garbage-Digester Explosion

An explosion of one of the garbage digesters at the Syracuse Municipal Reduction Plant at about 8 o'clock on the evening of Mar. 20, badly wrecked the plant (Fig. 1), causing an estimated loss of $80,000, but fortunately without loss of life or injury to any of the six men who were employed in the plant at the time.

It is understood that several of the digesters had been installed recently, and that the older ones had all been overhauled during the winter. They had been examined by

FIG. 1. WRECKED BY AN EXPLODING GARBAGE DIGESTER

boiler inspectors a few days previous to the explosion and had been pronounced in excellent condition.

The top of the exploded digester, Fig. 2, was thrown several hundred feet over the buildings and landed in an adjoining marsh. No details of the condition of the digesters has been obtained other than that an examination of the drums showed that the plates were much thinner than when first installed and that they were not strong enough to withstand the steam pressure carried, which was not supposed to be over 80 lb. The metal of the drums, which should have been $\frac{1}{16}$ in. thick, had so deteriorated that the plate was extremely thin in places and incapable of withstanding the pressure carried.

FIG. 2. TOP OF THE EXPLODED DIGESTER

It is to be remembered that digesters, although operating under comparatively low steam pressure, are subject to the corrosive action of acids and gases, which causes the wasting away of the plates and greatly reduces the strength of the riveted joints. These are probably responsible for the explosion, although the theory of frozen dynamite having been placed in the digester with the garbage, and that of the explosion of an accumulation of gas and steam in the digesters had been advanced.

Fortunately no fire followed the accident; and as a protection against further danger the fires were drawn from the boiler furnaces and the employees ordered from the building later on on account of the danger from falling walls.

# Points About Storing Coal

So many inquiries reach the Bureau of Mines, Department of the Interior, concerning the spontaneous combustion of coal that the bureau has issued the following general statement on the subject. The point of view of the bureau is as follows: The wisdom of establishing large storage piles is, of course, another matter which must be determined from the facts in each case.

The conditions of storage of coal are so various as to make it necessary to apply general principles in each case rather than specific directions.

It is to be recommended that coal should be stored in small quantities as near to the point of consumption as possible. Small coal piles rarely ignite from spontaneous combustion. Coal should be stored near the point of use to avoid rehandling, extra transportation, and the degradation of size which follows each rehandling. For these reasons the bureau would advocate storage, so far as possible, in the bins and yards of the ultimate consumer, thus dividing the risk of loss from spontaneous combustion. If large storage piles are necessary, certain general principles must be borne in mind. The generation of heat is the result of slow oxidation of the coal surface. The oxidation is much more rapid from freshly mined coal or from freshly broken surfaces. The oxidation rate increases rapidly with increased temperature. Different coals have different oxidizing rates. These facts lead to the following recommendations:

Where there is choice of coal to be stored, that having the lowest oxidizing rate should be chosen, if known. Between two coals, that which is least friable, and therefore which presents the least total coal surface in the pile, should be selected. The method of handling should be such as to produce the least freshly broken coal surface. The coal should be as cool as possible when piled. Piling warm coal on a hot day is more likely to produce spontaneous combustion. The coal must be kept from any extraneous source of heat. Alternate wetting and drying of coal during piling is to be avoided if possible.

The fine coal, or slack, which furnishes the larger coal surface in the pile, is the part from which spontaneous combustion is to be expected. Piling of lump coal where possible is therefore desirable. In the process of handling, if the lump coal can be stored and the fine coal removed and used immediately, the practice prevents spontaneous combustion in coals which would have otherwise given trouble.

The sulphur content of coal is believed by many to play an important rôle in spontaneous combustion. The evidence on this point is still conflicting, but to play safe, it is desirable to choose coal having a lower sulphur content, when choice is possible.

There is a current belief that dissimilar coals stored in one pile are more liable to spontaneous combustion. The evidence on this point is also conflicting, but to play safe, it is advisable to store only one kind of coal in a pile. The ground on which a coal pile is built should be dry.

The foregoing recommendations are all derived from the factors affecting the heating of coal.

There should be no spontaneous combustion, whatever the heating rate, provided the heat is carried away as rapidly as produced. This fact brings about the following recommendations: Coal piles should be so made that there is ready movement of air for ventilation throughout all parts of the coal pile. This is the condition when the entire pile is made of coarse lump coal. With ordinary coal piling, this is difficult.

The surfaces of coal piles should be so exposed as to allow the pile to cool; or else the coal should be so stored that air circulation within the pile is very small. When the air circulation is reduced to a minimum, as in an air-tight bin with no opening in the bottom, the oxygen of the air is soon removed and the mass of the coal lies in an inert atmosphere, except for small local circulation near the surface. Air-tight bins are usually impracticable, but the following practice is recommended to approximate these conditions:

In making a coal pile of mixed sizes, the coal should be so handled as to make a homogeneous pile and prevent the segregation of coarse and fine coal. This frequently determines the most desirable machinery for unloading coal.

It is common practice to limit the height of a coal pile; this for two reasons: A pile too high crushes the lower layers of coal, producing more fines; the larger the pile the less heat-dissipating surface there is exposed in proportion to the heat-generating capacity of the pile. Twelve feet in height is a common limit.

Whatever precautions are taken in the choice and handling of coal, provision should be made for keeping track of the temperature rise in a coal pile and for rapid rehandling of portions of a pile in case of excessive heating. In a coal pile covering a considerable area, it should be so subdivided that in case of spontaneous combustion of a portion, the heat will not be transmitted to the whole pile, thus accelerating the heating of portions of the pile which normally would have remained cool.

To keep track of the temperature of coal piles, it is recommended that half-inch iron pipe be driven vertically into the pile at distances of fifteen or twenty feet apart. A maximum thermometer lowered into the pipe to varying depths will indicate the temperature of the pile opposite the thermometer.

A survey of the pile and a survey of the temperature of all parts of the pile should be made twice a week during the first three months after the pile is made, and once a week thereafter until the pile has evidently ceased to heat. As soon as any portion of the pile reaches a temperature of 150 deg. F. provision should be made for removing that portion of the pile. Actual removal need not begin until the temperature has reached 180 deg. F., but at these temperatures the rate of oxidation is dangerously rapid. The object of rehandling the coal is to allow it to cool below a dangerous temperature. Any method of rehandling which does not allow of cooling will only transfer the difficulty from the old pile to the new one. It is generally useless to employ water in an attempt to cool a coal pile.

Lack of provision for rapid reloading, cooling and repiling of coal is the cause of serious loss from spontaneous combustion.

## Zone Distribution for Bituminous Coal

United States Fuel Administrator Garfield on Mar. 30 signed formal orders instituting the zone system of distribution for bituminous coal. Twelve general orders, imposing upon the movement of coal the limitations arranged by the Fuel Administrator and the Director General of Railroads were issued. They will be communicated at once to those charged with the enforcement of the zone-system distribution plan. Each order covers a single consuming zone.

The orders of the Fuel Administrator are directed to the operators in the various producing fields, which are limited in their shipments to specified consuming territory. They are supported by embargoes imposed by the Director General of Railroads on all coal movement except along the lines laid down in the zone-system plan.

The orders directing coal producers to restrict their shipments to the coal-consuming territory alloted to them became effective at 7 a.m., Monday, Apr. 1.

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The Municipal Electrical Association, comprising 187 towns in England, has been discussing the question of linking up stations, so that one can assist the other with current if necessary. In this connection it is proposed to divide the country into 16 areas.—*Commerce Reports.*

# Electrical Energy from the Volterra "Soffioni"

The large works of Count Larderel for the recovery of borax from the hot springs that abound in the volcanic district to the south of Volterra have long been known. There the volcanic district for many miles round is punctuated with *soffioni*—blasts of hot borax-bearing steam which breaks through the natural crevices of the soil.

For many years it was only for the recovery of the borax that this steam was utilized, but of late a new departure has been made which is interesting both for the ingenuity of the methods devised for overcoming technical difficulties and for the importance it may reach.

The earliest experiments for utilizing the Volterra steam for producing power date back to 1903, when Prince Ginori-Conti had a powerful jet of natural steam directed onto the vanes of a waterwheel, but the apparatus was little more than a toy. Later on he used the steam in a reciprocating engine which sufficed to drive a small dynamo and provide current for a few lamps. Encouraged by the development of these experiments, the prince set up a larger engine of 40 hp., which also was actuated by the natural steam just as it rose from the ground. The results obtained were satisfactory in a way, but the rapid corrosion of the metal work by the sulphuric acid and other impurities that contaminated the raw steam were a serious drawback. However, in the hopes that this obstacle might by some device be overcome, several borings were made reaching from a depth of from 100 to 180 meters (328 to 590 ft.), in which iron tubes, of a bore varying from 20 to 40 centimeters (7.87 to 15.75 in.), were fixed. Jets of superheated steam were thus obtained in large quantities. The production of the several shafts varies from 5000 to 20,000 kg. (11,023 to 44,092 lb.) of steam per hour, the pressure from 2 to 3 atmospheres (29.4 to 34.1 lb.), while if the aperture of the tube is completely closed the pressure rises to 4 or 5 atmospheres (58.8 to 73.5 lb), and the temperature ranges from 150 deg. to 180 deg. C.

This source of possible power is clearly important in quantity, and is susceptible of great development, for experience shows that shafts can be sunk as close to each other as are the oil wells in a Pennsylvanian field without interfering with their respective production, and the ground in which they can be sunk with good results extends over several square miles. But before this source of power could be made commercially available some means had to be devised for getting over the corrosion of the metals in the apparatus used.

The first attempt on anything like a large scale was made with a jet of 25,000 kg. (55,115 lb.) of steam per hour at a pressure of 2 atmospheres (29.4 lb.). Theoretically, this would provide about 4000 hp., 40 per cent. of which could be practically utilized. What was actually done was to install in 1912 a turbine of 300 hp., coupled to an alternator, providing a current sufficient for lighting the Larderel establishment. The results obtained were considered good enough to justify the erection of a plant on a larger scale, and the huge increase in the cost of coal caused by the war, owing to which coal has actually been sold on the wharves of Genoa up to £20 ($97.33) per ton, provided an additional motive for pushing on the work. Three turbines were built by Tosi, of Legnano, coupled to alternators for the production of 3000 kw. each. The corrosion problem was tackled in this way. The steam from the *soffioni* was not sent direct into the turbines, but was used to heat three groups of low-pressure (1¼ atmospheres or 18.37 lb.) tubular boilers supplied with pure water, the condensed steam being collected for the recovery of the boracic acid and the other byproducts which it contains. The boilers that produce the steam for feeding the turbines are vertical and the tubes are of aluminum, as being less affected by the acids contained in the steam which provides the heat for boiling the water in the secondary boiler. Each of these turbines develops about 4000 hp., and they are coupled to three alternators of 3000 kw. each. The electric current, which by the transformers is raised to 36,000 and 16,000 volts, is distributed by five distinct lines to various towns. Last summer only two of the groups were used, the third being held in reserve, but other turbines were under order, and the power produced will probably be largely increased in the near future. The latest information to hand is that the company has sold more power than it can at present produce. It is in contemplation to provide motive power from this source, in substitution for coal-raised steam, to the two important steel works situated on the cost at Piombino—the Alti Forni and the Magona d'Italia. A scheme of treatment is also under consideration for the recovery of helium and other rare gases, which may be used for the making of electric lamps and other purposes.

Of the economical results of the scheme it is as yet too early to say anything positive. Even if the management were willing to divulge them, it is hardly likely that it has yet been able to determine their costs with any accuracy. With coal at its present price almost any source of energy may be scrambled for, but when normal times return the question of finance will assume a different aspect, and the plant now working must therefore still be looked on, from the profit and loss point of view, as something of an experiment, though the able men who work it are not lacking in confidence. It will take a longer experience to determine, not only the ultimate efficiency of the plant, but also what will be the cost of repairs for boilers working under the trying conditions to which they are subject. How will this cost compare with that of water turbines?

For the technical details of these notes and the illustrations we are indebted, says the *Engineer*, to Engineer Professor Luigi Luiggi, inspector of the Genio Civile, and an authority of unquestionable competence.

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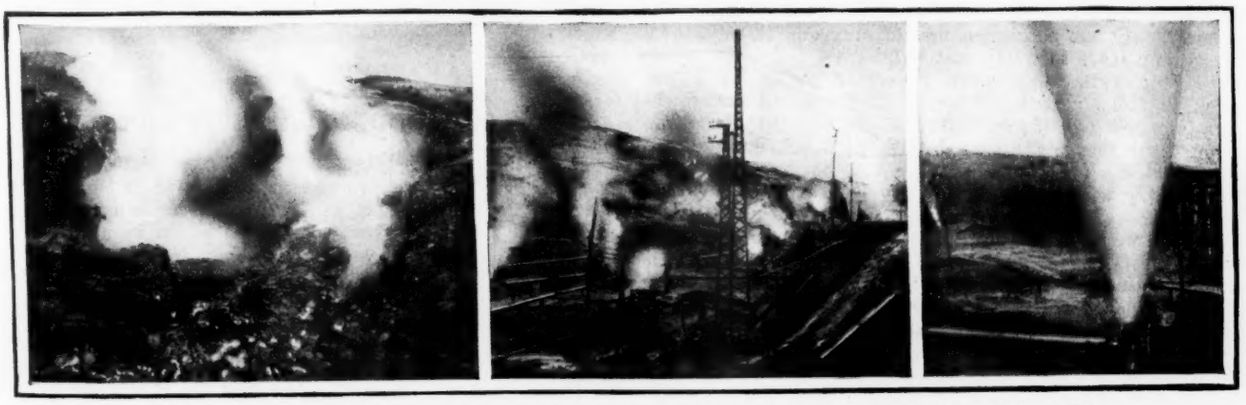
If the War-Savings and Thrift-Stamp campaign attains the goal set, it will cover the entire cost of the Government's shipbuilding program for the year. Already the Government is receiving from the buyers of War-Savings Stamps daily, enough money to build more than 10,000 tons of shipping. It has already received funds for the building of 420,000 tons or 84 ships of 5000 tons each.



STEAM FROM EARTH FISSURES, STEAM-PIPE LINES AND STEAM JET ISSUING FROM A PIPE

## Water-Power Legislation Agreement Made

It is understood in Washington that the Special Joint Water Power Committee of the House of Representatives has agreed to incorporate in the Shields bill, passed by the Senate some time ago, all the features of the so-called Administration water-power bill agreed upon by the committee. The Shields bill, when it passed the Senate, was referred to the House Committee on Interstate and Foreign Commerce, and that committee has referred it to the special committee which has been holding hearings on the Administration bill for some time.

Senators are expressing satisfaction that a way has been found out of a legislative difficulty, by the special committee of the House deciding not to bring in the Administration bill as a separate measure. Some Senators have entertained the idea that as the Senate has recently dealt with water-power matters and officially expressed itself in the Shields bill, there would be little opportunity for substituting the Administration bill from the House for the Shields bill in the Senate. The plan now is for the House to amend the latter bill by incorporating the features of the Administration bill. The bill as so amended will then be submitted to conferees on the part of the House and Senate. Senator Shields will be manager of the conferees on the part of the Senate and Judge Sims, chairman of the House Special Committee, will be manager on the part of the House. It is authoritatively stated in Washington that Senator Shields has made up his mind to accept a number of the most important provisions of the Administration bill when they are tacked on to his bill as amendments, and there is a general disposition among other Senators to urge the measure to completion.

The measure must nevertheless go through a number of slow-moving processes before coming to be a law, as in all likelihood there will be debate on it in the House and in the Senate. It is said in Washington that if there is a disposition in the House to retard the passage of the bill unduly, a rule will be brought in by the Rules Committee, shutting off debate.

Brief additional hearings were held on the bill Thursday, Apr. 4, before the House Special Committee. As this is written in Washington, however, the committee feels that it has had laid before it practically all the facts upon which it needs to act.

## Marking Packages for Express Shipment

The express companies have issued what is termed Supplement No. 5 to Official Express Classification No. 25. This refers to the marking on packages, bundles, etc., and it goes into effect May 1, 1918. Some of its requirements, which may be of interest to *Power* advertisers and readers, follow:

*(a)* Each package, bundle or loose piece in a shipment must be plainly, legibly and durably marked, showing the name of only one consignee, and of only one station, town or city and state to which destined.

*(b)* Shipments wrapped in paper, or packed in boxes, crates, barrels, corrugated paper or fiberboard containers must be marked with pen, brush, stencil, waterproof crayon, or by label securely attached with glue or equally good adhesive. Such shipments must not be accepted when marked only with tag except as provided below:

Shipments of iced goods, such as fish, oysters, etc., must be marked with brush, stencil or waterproof crayon, or with two tags securely tacked, one of which must be sunk in a groove in the box or case, or otherwise protected in such manner as to prevent becoming detached or defaced by contact with other articles or surfaces.

Containers which are customarily used several times for transportation of goods by express, such as bread boxes or dog kennels, which cannot be satisfactorily marked with brush, stencil, waterproof crayon or label, may be accepted when bearing two address tags securely attached to the package.

*(c)* Castings, machine parts, shafting, pipe, rods, bars, and other metal articles:

1. When boxed, barreled, crated or trussed, must be marked in compliance with paragraph *(b)*.

2. When not boxed, barreled, crated or trussed, and there is sufficient smooth surface for the purpose, the address must be plainly marked on the article with durable paint. Such shipments must not be accepted unless marks are thoroughly dry.

3. When not boxed, barreled, crated or trussed, or when not possible to mark as provided in preceding paragraph, shipments must be marked with not less than two wooden, leather, metal, cloth, rope stock or sulphite fiber-tag-board tags. Rope stock or sulphite fiber-tagboard tags must test not less than 14 point, 50 per cent. rope, have reinforced metal eyelets and cord must be attached by wire not less than 23 gage, or strong tarred cord. Tags must be attached wherever possible to unexposed parts of the article in order that they may not become detached in handling.

4. Rods, shafting, bars, iron-bed slides, automobile springs and other articles of like character marked with tags as provided in paragraph 3 must have the tags securely wired to the article, and in addition, a concealed tag bearing the same address, must be bound to the article with burlap covering, the latter securely wired at each end.

5. When metal articles are shipped in sacks, the address must be shown on tag conforming to the specifications in paragraph 3, attached either by wire or strong cord, and an additional tag bearing the same address must be inclosed in the sack.

Except when in carloads, each package or article in a lot shipment must be marked in compliance with these requirements.

Shipments not marked in accordance with the foregoing requirements, or as noted under individual items of the Classification, must be refused.

## Petroleum in Britain

Lord Cowdray has addressed a letter to the press which requires the most careful consideration, both of the government and the public. It appears that he has offered on behalf of his firm to (1) place at the government's disposal the services of his technical staff for the duration of the war, for the purpose of investigating and exploiting oil fields in Great Britain, entirely free of cost; (2) to survey, drill and exploit at their own entire cost, subject to certain areas being reserved to the firm as licensees, who will spend at least £500,000 ($2,433,250) on the work. Thus the nation would incur no expenses, but would stand to gain both directly and indirectly. The point that requires most immediate attention is the statement that legislation is required; otherwise if the government proceeds under the Defense of the Realm Act, all discoveries made and work done would revert to the landowner after the war. That should not be. If petroleum exists in these islands in any quantity, it should be made national property. — *The Engineer.*

## Production of Fuel Briquets

The output of fuel briquets in the United States in 1917 was 406,856 net tons, valued at $2,233,888, an increase over 1916 of 111,701 tons, or 38 per cent. in quantity, and of $788,226, or 55 per cent. in value, again breaking the record of the previous year.

According to C. E. Lesher, of the United States Geological Survey, Department of the Interior, the demand for fuel in 1917 was so strong throughout the whole year that there was no lack of market to limit the production of the briquet manufacturers. Despite the increased cost of binders and of manufacturing, most of the plants operated to full capacity and reported a prosperous year.

## Obituary

**Merrick M. Childs,** for 22 years manager and superintendent of the Metcalf Building, Providence, R. I., died at his home at Edgewood on Mar. 31, after an illness of three weeks. His health had been poor for about two years. He was treasurer of the National Association of Stationary Engineers, No. 1 for 17 years, and previous to that had been president for three terms. He was a director of the Nichols Manufacturing Co. and also a Civil War veteran. He was born in Woodstock, Conn. He is survived by his widow and one daughter.

## Personals

**H. O. Savage** has been elected vice president of the Locomotive Pulverized Fuel Co. of New York. He will also continue as vice president of the American Arch Co.

**George M. Keenan,** formerly test engineer of the Union Electric Co., St. Louis, Mo., is now chief engineer of the Little Rock Railway and Electric Co., Little Rock, Ark.

**Henry A. Stringfellow** has resigned from the Epping-Carpenter Pump Co., Pittsburgh, Penn., to accept the position of first assistant engineer with R. Winthrop Pratt, consulting engineer, on the design of the new filtration plant for the City of Detroit, Mich.

## Engineering Affairs

**The American Association of Engineers** will hold its fourth annual convention in Chicago, May 14.

**The Southwestern Electrical and Gas Association** will hold its annual convention at Galveston, Tex., Apr. 15-16.

**The Southwestern Society of Engineers** wil hold its annual convention at Douglas, Bisbee and Tuscon, Ariz. Apr. 18-20.

**The American Society of Heating and Ventilating Engineers** will hold a meeting on the evening of Apr. 15, which will be devoted to "Fuel Conservation."

**American Association of Engineers**—Garrett P. Serviss, the prominent scientist and author, will address the New York Chapter at its next meeting on Wednesday, Apr. 10, at the Hotel McAlpin, at 8 p.m. His subject will be, "The Glory of the Engineer."

**The American Institute of Electrical Engineers** will hold a meeting on the evening of Apr. 12. The following papers will be presented: "A Physical Conception of the Operation of the Single-Phase Induction Motor," by B. G. Lamme; "No-Load Conditions of Single-Phase Induction Motors and Phase Converters," by R. E. Hellmund.

## Miscellaneous News

**The Northwestern Electric Co.** of Portland, Ore., has started the construction of a $1,500,000 additional power plant in this city which will have a capacity of 10,000 kw. or 13,400 hp., with an ultimate development of 40,000 hp.

**The City Officials** of Seattle, Wash., have decided to make a thorough investigation of all power sites offered recently before awarding the contract for the construction of a new plant. The opinion seems to favor the acceptance of the bid of Grant Smith & Co. for the construction of a plant to cost $2,100,000.

**The Northern Idaho and Montana Power Co.,** Kalispell, Mont., has been sold at public auction for $563,166 to Robert J. Graf, representing the stockholders of the company. His bid was the only one received and was made for him by John L. Roemer, a Chicago attorney. The power company became insolvent some time ago and was ordered sold at auction. The Continental and Commercial Trust and Savings Bank, of Chicago, is the trustee for the bondholders, which has held the deed of trust in order to secure its issue of about $4,000,000 in bonds.

**The Nevada-California Power Co.** is contemplating one of the longest transmission lines in the country. The company has its headquarters at Riverside, Calif., and has been working out details of its scheme with a view to saving power to railroad companies that have been engaged in hauling fuel to the Nevada Consolidated Companies' plant at Ely, Nev. The 24-hour shift of the company has an equivalent of 20,000 hp., and this could be used to good advantage for a saving of fuel. The Nevada Consolidated now generates its own power with local steam plants, which call for an immense tonnage of fuel that is difficult to deliver in the present congested condition of traffic, and anything that would relieve the company from the uncertainty of getting power would be welcome, even though the cost would be in excess of the present showing. The copper company is mining by the steam-shovel method and concentrating the ores at the rate of 10,000 tons a day. The cost of the installation would be approximately $300,000 for the pole line alone. Before engaging in its construction or entering into a definite contract, the power company would have to secure the consent of the Government for a priority order of delivery for the material required in the construction, as it would be impossible to secure any considerable material without this arrangement. Should the deal become effective, the Nevada Consolidated would become the largest individual consumer of electric power in the West and the electric companies' service would extend over a distance of 300 miles from Inyo county almost to the Utah line.

## Business Items

**The H. W. Johns-Manville Co.** announces the removal of its Memphis (Tenn. office to new quarters at 804-5 Exchange Building, Madison Ave. and Second Street.

**Smith Serrel Co., Inc.,** 90 West St., New York City, are now manufacturing the Pintite rigid couplings for line shafting, which are made in shaft sizes from 1½-in. to 4-in. This coupling was described on page 223 of the Feb. 17, 1914, issue and was at that time manufactured by the Thomas Coupling Co., Warren, Penn.

**The Hawes Foundry and Equipment Co.,** with a capitalization of $250,000, has just announced its acquisition of the Central Bronze Co., which concern will cooperate with its other plants in turning out a complete line of bronze valves and fittings. All its products will be marketed and distributed as in the past, through its principals, the John Wilfert Co., of New York, Brooklyn, St. Louis and Buenos Aires.

**MacGovern & Co.,** of 114 Liberty St., New York City, well-known dealers in second-hand equipment, announce the opening of branch offices at Pittsburgh, Penn., and St. Louis, Mo. The office in Pittsburgh is located at 498 Union Arcade, and is under the direction of L. H. Tippins and W. L. Sprengle. The St. Louis office is at 315 North 12th St., and is under the direction of R. S. Fisher, district manager.

**The Big California-Oregon Power Co.** Dam at Copco, Calif., on the Klamath River has been completed and the reservoir which is formed has been filled. This, together with the construction of a similar dam lower down the river, will give the company a total of 103,000 hp. from this one source. The dam just completed is considered one of the great engineering feats of the country. It is 95 ft. across at the base and 500 ft. at the top. It develops 26,000 hp. and cost $1,500,000.

## Trade Catalogs

**"The Pump that Manistee Builds."** The Maniste Iron Works, Manistee, Mich., Pp. 12; 9 x 6 in.; illustrated. This booklet illustrates the design and construction of the RO TURBO centrifugal pump, made by the Manistee Iron Works, in a most unusual way. Instead of the ordinary series of halftone views of the various features of the pump, the booklet contains a cleverly arranged series of pictures of each part. These are cut out and arranged one over the other so that in turning the leaves the reader sees the pump just as he would see an actual model being taken apart. Thus, turning the first page removes the bearing cap. Turning the next page removes the thrust cap and bearing bracket. Each page in turn shows the pump in a more disassembled condition until the last page shows just the holow pump casing. Not only is this booklet one of the most novel publications ever issued by a machinery house, but it makes the design and construction of the RO TURBO pump so clear that a copy should be in every engineer's library.

## NEW CONSTRUCTION

### Proposed Work

**Mass., Cambridge**—The Cambridge Electric Light Co. 46 Blackstone St., is receiving bids for the erection of a 1-story, 30 x 50 ft. addition to its power plant. Noted Jan. 22.

**N. Y., Albany**—State Dept. of Health will receive bids until May 8, for the installation of heating and illuminating systems in laboratory on New Scotland Ave. H. Biggs, Comr.

**N. Y., Buffalo**—The Demarest Heating Corporation, 21 The Terrace, has increased its capital stock from $10,000 to $50,000; the proceeds will be used to make alterations and build additions.

**N. Y., Buffalo**—The Frontier Water and Steam Supply Co., 667 Main St., has increased its capital stock from $40,000 to $150,000; the proceeds will be used to make alterations and build additions.

**N. Y., Buffalo**—The Lackawanna Steel Co. Hamburg Turnpike, is having plans prepared for the erection of a 1-story, 100 x 190 ft. central turbo generator power plant. Estimated cost, $200,000.

**N. Y., Buffalo**—The National Aniline and Chemical Co., Abbott Rd., plans to build a power house in connection with its plant. Estimated cost, $8500.

**N. Y., Buffalo**—The Power Efficiency Corporation, 102 Clinton St., has plans under consideration for additions and improvements to its plant.

**N. Y., Jamestown**—The Crescent Tool Co., 202 Harrison St., is having plans prepared for a power station to be erected at its plant. Noted Feb. 26.

**N. Y., Niagara Falls**—The State Reservation Commission is having plans prepared by F. N. Williams State Engr., Capitol, Albany, for a power plant to be erected on Goats Island. Estimated cost, $3,000,000.

**N. J., Bridgeton**—City has plans under consideration for the installation of an electric lighting plant.

**N. J., Newark**—Maas & Walstein, Inc., Ave. R., has had plans prepared for the erection of an addition to its power plant and alterations to its boiler room. Estimated cost, $12,000.

**N. J., Trenton**—City is considering plans for a hydro electric plant to be erected on the Sanhican Creek. J. R. Fell, Jr., City Engr.

**N. J. Trenton**—J. E. Thropp Sons Co., Lewis St., will receive bids until Apr. 19, for the erection of an iron plant to include a power house, foundry, etc. Estimated cost, $100,000. J. O. Hunt, 114 North Montgomery St., Engr.

**Penn., Philadelphia**—The Bureau of Yards and Docks, Navy Dept., Wash., will soon award the contract for furnishing and installing at Navy Yard, here, exciters, switchboards, cell structures, cell equipment, wiring transformers, etc.

**Penn., Portersville**—The Fox Coal Co., Brannan, near here, has had plans prepared by C. D. Hall, Engr., Jenkins Arcade, Pittsburgh, for the erection of a power house at its plant.

**Md., Baltimore**—The Baltimore Manufacturing Co., Monument and Constitution St., is having plans prepared for the erection of a new power station on Central Ave. and Bank St.

**Va., Norfolk**—The Bureau of Yards and Docks, Navy Dept., Wash., will soon award the contract for furnishing and installing at Navy Yard, here, exciters, switchboards, cell structures, cell equipment, wiring, transformers, etc.

**Ga., Valdosta**—The Ocean Pond Club House plans to install an electric lighting plant to supply light to the house and grounds.

**Ala., Chickasaw**—The Chickasaw Shipbuilding Co. plans to build an electric generating plant to cost $750,000 in connection with its shipbuilding plant now under way at Mobile.

**Tenn., Columbia**—M. R. Sterns, Nashville, and associates, plans to organize a company with $200,000 capital stock, to build and operate an electric generating plant on the Duck River, near here.

**Ky., Somerset**—The Southern Machinery Exchange is in the market for a 150 kw., direct current, 250 volt belted generator and engine, or direct connected set.

**Ohio, Bedford**—The Owen Tire and Rubber Co., 1900 Euclid Ave., Cleveland, will build a 1-story, 250 x 250 ft., reinforced, concrete, steel and brick factory and power house; also install a high pressure boiler, steam engine and dynamo. Estimated cost, $125,000.

**Wis., Brodhead**—The Brodhead Electric Light and Power Co. has had plans prepared by Power Eng. Co., Engrs., 512 Corn Exchange, Minneapolis, Minn., for the erection of a 2-story, 40 x 80 ft., brick and rein.-con. hydro electric plant. K. Guelson, Supt. Noted Mar. 19.

**Wis., Superior**—E. Kaner has acquired a site and plans to build a plant and will install electric cranes in same.

**Minn., Crosby**—City voted to issue $76,000 bonds for the installation of an electric-lighting plant.

**Wyo., Manville**—City plans to build an electric-lighting plant. Estimated cost, $30,000.

**Ark., Buffalo**—The Dixie Mining Co. will soon award the contract for the erection of an electric lighting and power plant. Address A. C. Barnhart, Wheat Bldg., Ft. Worth, Tex. Noted Apr. 2.

**Ark., Delight**—B. F. Ryon, Texarkana, has been granted a franchise to build an electric lighting plant here.

**Ark., Diaz**—The Wilmans Mercantile Co. is in the market for machinery including power plant equipment, crusher, etc.

**Ark., Hominy**—The Hominy Ice, Light and Power Co. is in the market for machinery including a 150 hp. gas engine, direct connected to a 100 kw., 3 phase, 2300 volt generator.

**Ark., Rector**—The King Mercantile Co. is in the market for equipment for its power plant and cotton gin. About $25,000. L. King, Pres.

**Tex., Texas City**—The Texas City Electric Light and Power Co. plans to build an electric power station; also install a 100 kw. turbo generator with convertor, for street railway service and an emergency unit. R. C. Trubex, Mgr.

**Okla., Blackwell**—City plans to install additional electric lighting equipment. Estimated cost, $82,500.

**Okla., Ferguson**—The Blaine County Salt Co. plans to install electrical equipment in its new salt plant.

**N. M., Columbus**—The Columbus Electric Light and Power Co. plans to build a power plant here. Estimated cost, $30,000. J. L. Greenwood, Pres.

**Wash., Seattle**—The Rothert Process Steel Co., 622 Harriman St., plans to install a 10 ton electric furnace.

**Calif., Oakdale**—The Sierra and San Francisco Power Co., 58 Sutter St., plans to rehabilitate its old hydro-electric plant at Knights Ferry. Estimated cost, $10,000. M. C. McKay, Supt.

**Ont., Drummondsville**—The Dominion Power and Transmission Co., Terminal Bldg., Hamilton, has had plans prepared for the erection of a hydro electric plant. New electrical equipment will be installed. E. R. Coleman, Gen. Mgr.

**Ont., Oshawa**—Bradley Bros. is in the market for a 5 hp., 220 volt, single phase, electric motor, 170 r.p.m.

**Ont., Owen Sound**—The Empire Stove & Furnace Co., Ltd., is in the market for three 15-20 and 25 hp., 60 cycle, 550 volt, 3 phase motors, either new or second hand.

**Ont., Owen Sound**—Keenan Bros., Ltd., is in the market for a 60-75 hp. engine.

**Ont., Toronto**—The Universal Products, Ltd., 43 Britain St., is in the market for one 5 hp. and one 10 hp., 230 volt, direct current, medium speed motor.

**Ont., Toronto**—E. Whiting, 122 King St., E., is in the market for an 18-30 hp. steam traction engine.

**Que., East Broughton**—The Quebes Asbestos Co. plans to spend $30,000 for a power plant.

### CONTRACTS AWARDED

**Mass., Boston**—The Tilestone and Hollingsworth Co., 49 Federal St., is building a reinforced concrete transformer house. Electric motive power is being installed.

**Mass., East Hampton**—The Glendale Elastic Fabrics Co., 52 Union St., is building a 1-story, 65 x 75 ft. power plant and switchroom. Estimated cost, $10,000.

**Mass., New Bedford**—The New Bedford Textile Co., 247 Shawmut Ave., is building a 1-story, 25 x 40 ft. boiler plant. Estimated cost $40,000.

**Mass., Springfield**—The Undertakers Supply Corporation, Stearns Bldg., has awarded the contract for the erection of a new 25 x 30 ft. power house, to Gour Bros., 20 Woodmont St.

**R. I. Westerly**—The Narragansett Electric Light Co., Providence, has awarded the contract for the erection of a 1-story, 30 x 72 ft. addition to the gas house of the Westerly Light and Power Co., to the Joslin Lena Co., 20 Mechanic St.

**Conn., Hartford**—The Pratt & Cady Co., Capitol Ave., has awarded the contract for a 1-story, 30 x 103 ft. concrete and brick boiler room to be erected at its foundry on Cushman St., to Porteus & Walker Co., 13 Forrest St. Estimated cost, $23,000.

**N. Y., New Hampton**—The Department of Corrections, Municipal Bldg., New York City, is building a power house at the reformatory here.

**N. Y., Syracuse**—The Swan & Finch Co., 416 Tracey St., has awarded the contract for the erection of an addition to its power house, to F. M. Kimmey, 1007 West Onondaga St.

**Penn., Indian Creek**—The Mountain Water Supply Co. has awarded the contract for the erection of a 1-story, 31 x 71 ft. power plant, to the Rust Eng. Co. Penna. Bldg., Philadelphia. Estimated cost, $35,000.

**Penn., Philadelphia**—The Fretz Co., Ontario and Brabant St., has awarded the contract for the construction of a new engine and boiler house, to H. E. Brocklehurst, 512 West Norris St. Estimated cost, $19,000.

**Penn., Pittsburgh**—The Arrott Estate, Arrott Bldg., has awarded the contract for a new power plant to be erected on Barker Pl. to replace the one recently destroyed by fire, to Rose & Fisher, 821 Penn Ave. Estimated cost, $15,000.

**Penn., Pittsburgh**—The South Pittsburgh Water Co., Carrick, has awarded the contract for the erection of a new 45 x 115 ft. power house, to the Walker & Curley Co., Trust Bldg. Estimated cost, $35,000.

**Ala., Columbia**—The Columbia Power Co. has awarded the contract for enlarging its plant at Omussee, to Tucker & Laxton, Inc. Charlotte, N. C. Estimated cost, $500,000.

**Wyo., Wheatland**—The town has awarded the contract for a 120 kw. generator directly connected and a new switchboard, to the Fairbanks-Morse Co. Noted Mar. 5.

**B. C., Vancouver**—The Wallace Shipbuilding Co. has awarded the contract for reconstructing the entire power system to the Mudy Rowland Co.

## THE COAL MARKET

**Boston**—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

| | Circular Apr. 4, 1918 | Individual Apr. 4, 1918 |
|---|---|---|
| Buckwheat | $4.60 | $7.10—7.35 |
| Rice | 4.10 | 6.65—6.90 |
| Boiler | 3.90 | ..... |
| Barley | 3.60 | 6.15—6.40 |

BITUMINOUS

Bituminous not on market.

Pocohontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.00 a year ago.

*All-rail to Boston is $2.60. †Water coal

**New York**—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

| | Circular Apr. 4, 1918 | Individual Apr. 4, 1918 |
|---|---|---|
| Pea | $4.90 | $5.65 |
| Buckwheat | 4.45@5.15 | 5.10@5.85 |
| Barley | 3.40@3.65 | 3.10@4.10 |
| Rice | 3.90@4.10 | 4.10@4.85 |
| Boiler | 3.65@3.90 | ..... |

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

| | F.o.b. N. Y. Gross | Mine Price Net | Gross |
|---|---|---|---|
| Central Pennsylvania | $5.06 | $3.05 | $3.41 |
| Maryland— | | | |
| Mine-run | 4.84 | 2.85 | 3.19 |
| Prepared | 5.06 | 5.05 | 3.41 |
| Screenings | 4.50 | 2.55 | 2.85 |

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The ratte to the upper ports is 5c. higher than to the lower ports.

**Philadelphia**—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

| | Line | | Tide | |
|---|---|---|---|---|
| | April 4, 1918 | One Yr. Ago | April 4, 1918 | One Year Ago |
| Pea | $3.75 | $2.80 | $4.65 | $3.70 |
| Barley | 2.15 | 1.85 | 2.40 | 2.05 |
| Buckwheat | 3.15 | 2.50 | 3.75 | 3.40 |
| Rice | 2.65 | 2.10 | 3.65 | 3.00 |
| Boiler | 2.45 | 1.95 | 3.55 | 3.15 |

**Chicago**—Steam coal prices f.o.b. mines:

| Illinois Coals | Southern Illinois | Northern Illinois |
|---|---|---|
| Prepared sizes | $2.65—2.80 | $3.35—3.50 |
| Mine-run | 2.40—2.55 | 3.10—3.25 |
| Screenings | 2.15—2.30 | 2.85—3.00 |

| Smokeless Coals | So. Ill., Pocohontas, Pennsylvania and W. Va. | Hocking, East Kentucky and West Va. Splint |
|---|---|---|
| Prepared sizes | $2.60—2.85 | $2.85—3.35 |
| Mine-run | 2.40—2.60 | 2.60—3.00 |
| Screenings | 2.10—2.55 | 2.35—2.75 |

**St. Louis**—Prices per net ton f.o.b. mines a year ago as compared with today are as follows:

| | Williamson and Franklin Counties April 4, 1918 | Mt. Olive & Staunton April 4, 1918 | Standard Apr. 4 1918 |
|---|---|---|---|
| 6-in. lump | $2.65-2.80 | $2.65-2.80 | $2.65-2.80 |
| 2-in.-lump | 2.65-2.80 | 2.65-2.80 | 2.65-2.80 |
| Steam egg | 2.65-2.80 | 2.65-2.80 | 2.65-2.80 |
| Mine-run | 2.45-2.60 | 2.45-2.60 | 2.45-2.60 |
| No. 1 nut | 2.65-2.80 | 2.65-2.80 | 2.65-2.80 |
| 2-in. screen | 2.15-2.30 | 2.15-2.30 | 2.50-2.65 |
| No. 5 washed | 2.15-2.30 | 2.15-2.30 | 2.50-2.65 |

**Birmingham**—Current prices per net ton f.o.b. mines are as follows:

| | Mine-Run | Lump & Nut | Slack and Screenings |
|---|---|---|---|
| Big Seam | $1.90 | $2.15 | $1.65 |
| Pratt, Jagger, Corona | 2.15 | 2.40 | 1.90 |
| Black Creek, Cahaba | 2.40 | 2.65 | 2.15 |

Government figures.

Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule